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Philadelphia Number

THE SURGICAL CLINICS OF NORTH AMERICA

Volume 17

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SYMPOSIUM ON FRACTURES

The following clinics are included in this Symposium

Eldridge L. Eliason and Julian Johnson FRACTURES OF THE PELVIS

William Bates FRACTURE OF UPPER THIRD OF HUMERUS

L. K. Ferguson FRACTURES OF THE CARPAL SCAPHOID

Thomas J. Ryan THE RUSSELL EXTENSION

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Robert R. Impink, Clare S. Spackman and Walter Estell, Lec. THE USE OF
OCCUPATIONAL THERAPY IN THE TREATMENT OF FRACTURES

S. M. S. Medical College, Jaipur.

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CLINIC OF DRS ELDRIDGE L ELIASON
AND JULIAN JOHNSON

UNIVERSITY OF PENNSYLVANIA

FRACTURES OF THE PELVIS

ANATOMY AND FUNCTION OF THE PELVIC GIRDLE

IN the clinical study of fractures of the pelvic girdle it may be well to consider them from the standpoint of pelvic anatomy and function since here as in all fractures restoration of function is the chief aim. Fractures of the sacrum and coccyx will not be discussed in this article. The pelvis acts as (1) a mooring for muscles important in all postures and motions of the body (2) a weight carrier and (3) a bony encasement for abdominal viscera vessels and nerves. A brief consideration of the development and anatomic structure may be useful before detailed description of the subject is undertaken.

The position of the primary nuclei for the pelvic bones is as follows: (1) ilium above the acetabulum spreading rapidly through upper part of bones (2) ischium below the acetabulum (3) pubes in the horizontal ramus. The dates of appearance are: (1) third month of fetal life (2) usually before end of the third month (3) fourth to sixth month. The rami of the pubes and ischium unite at about the eighth year or earlier but the line may persist until the eighteenth year.

At birth all three nuclei are of considerable size, but are surrounded by relatively wide margins of cartilage. The pelvis of an infant is relatively small and continues so for several years. The peculiarity of the shape is largely due to the sacrum which is straight or nearly so, the promontory is very rudimentary thereby causing a narrow and funnel shaped pelvis.

There are several secondary centers in the Y shaped cartilage dividing the acetabulum and the three bones. These appear in the sixth to the tenth year. Lines of junction are

visible until the seventeenth or eighteenth year that between pubis and ischium persisting the longest. The "os acetabuli" persists until about the fifteenth year.

Other secondary centers occur in the crest of the ilium, anterior inferior spine, symphysis pubis and tuberosity of ischium. These appear about puberty to the fifteenth year. They are all fused about the twentieth year except perhaps, that of the crest of the ilium, fusion of which may be delayed. This line is one of the last in the body to disappear.

As a weight carrier, the pelvic girdle may be considered as composed of two main and two tie arches, one of which is in use when standing and the other when sitting. The sacrum is the common union of both. The femorosacral (standing) arch extends from the acetabulum to the sacrum. Falls on the feet result in force directed against this arch. The ischiosacral (sitting) arch extends from the tuber ischii to the sacrum. Falls on the buttocks result in force directed against this arch. The femorosacral arch is reinforced by the tie arch formed by the body and horizontal rami of the pubis. The ischiosacral arch is reinforced by the tie arch formed by the united rami of the ischium and pubis. Both ties are united at the symphysis. Thus it is seen the sacro iliac and symphyseal regions bear the brunt of all forces. Furthermore mechanical principles are responsible for the fact that tie arches break first and the main arches later, hence, the rami fracture from falls on the feet or buttocks, crushing forces applied laterally or anteroposteriorly result first in the tie arch rupture and then a spreading of the main arches, causing acetabular fracture or sacro iliac joint sprain with or without a fracture at or near this joint. Compression forces may fracture the crests of the iliac bones.

Muscle action may be responsible for fractures or epiphyseal separations at the crest, the anterior superior spine, the posterior superior spine and the anterior inferior spine. Fracture at the last site is caused frequently by sudden forcible contraction of the rectus femoris such as occurs in sprinters at the start of a dash. In fact, it is frequently termed "sprinter's fracture" and erroneously diagnosed as "charleyhorse" or "pulled tendon" in track vernacular.

From the standpoint of protection the pelvic framework is essential. In fact the seriousness of a pelvic fracture depends

upon the associated injuries to the urethra, bladder, intestines, large vessels and nerves in that order of frequency

CLINICAL CONSIDERATIONS

Fractures may occur in almost any portion of the pelvis and have become more common since the recent rapid development of mechanical manufacturing and transportation (Wheeler). Common sites are the rami of the pubis and ischium and the alae of the ilium. A not uncommon occurrence is a penetrating fracture of the acetabulum. Rarer interesting fractures are fractures through the symphysis pubis, and epiphyseal separation of the anterior superior spine of the ilium. Fractures of the pelvis are of more importance in respect to visceral complications than because of the injury to the bone itself. In young women pelvic deformity resulting from fractures may be of medicolegal importance as regards the expectancy of pregnancy. The fractures are often bilateral. Fracture of the acetabular rim simulates dislocation of the hip, a posterior displacement may exist in addition.

Fractures of the pelvis are usually the result of severe injuries. They were formerly encountered chiefly in heavy industry. The usual history was a fall from a height being struck by a falling object or being caught between two objects. The great majority of these cases were cared for by the relatively small number of surgeons who had an industrial practice. Since the advent of the automobile and the ever increasing number of traffic accidents fractures of the pelvis have increased accordingly. The injury may occur as the result of being thrown from the automobile or by a crushing accident. A goodly number occur when the passenger in the rear seat is thrown forcibly against the side of the car. Pedestrians also suffer fractured pelvis as the result of being knocked into the air, or thrown violently to the ground. Since the injured persons are naturally taken to the nearest hospital, patients with fractured pelvis may now be found in every hospital in the land. It has therefore become increasingly important that general surgeons throughout the nation familiarize themselves with the methods of handling these cases.

In former years the vast majority of fractures of the pelvis occurred in men.⁵ In the series of cases herein reported, how-

ever, 44 per cent are women. Sixty per cent of the nonindustrial cases are women. This is no doubt due to the fact that the female pelvis is more frail than the male pelvis and is broken with less force. In our series, there were three fractures which occurred in women as the result of minor injuries such as falling out of bed or tripping over a rug.

A fracture of the pelvis may be suspected by the history of trauma associated with pain and an inability to walk. In the worst cases, the patient will lie where he falls, complain of severe pain and may soon develop the signs of shock. When the trauma has been slight, there may be a fracture without displacement and the patient may get up and walk, although walking is seldom pain free. It is in this type of case, that there is a danger of an error in diagnosis. There will usually be localized pain and tenderness, but crepitus may not be elicited. Since there is no deformity, a definite diagnosis may not be possible except by x ray examination. The only safe procedure, therefore, is to x ray the pelvis in all cases when the patient complains of pelvic pain following trauma. In the vast majority of cases, however, a positive diagnosis can be made by the history and physical examination. The pubis and

and crepitus. Deformity of the crests of the ilium can easily

“charley horse”

A careful physical examination is usually very instructive, however, and x ray examination is necessary to determine the

more important. If patient is severely hurt, an examination for tenderness and crepitus should not be made for fear of increasing the shock.

When the pelvis is fractured, there is seldom only one fracture line. In our series of 60 acute cases, 80 per cent had more

than one fracture, and 20 per cent were bilateral. As a matter of convenience, the fractures have been listed in 4 groups. The groups are not mutually exclusive since a Malgaigne fracture breaks the pelvic ring twice, and a fracture of the acetabulum often breaks the pelvic ring. A considerable number of the patients might be listed in more than one group, because of multiple fractures. In the interest of clarity, this has been avoided. The classification is given below in the order of frequency as found in the reported series.

1 Fractures of the pelvic ring	31
2 Fractures of individual bones not involving the pelvic ring	10
3 Fractures of the acetabulum	8
4 The double vertical fracture of Malgaigne	6
Unknown	5
Total	<u>60</u>

FRACTURES OF THE PELVIC RING

Fractures of the pelvic ring constitute one half of the cases in the reported series. Because of the difference in the size of the bony structure of the anterior and posterior parts of the pelvic ring the fracture is almost always in the anterior part. There are only 3 cases in this series with a fracture of the posterior portion, while the anterior part remained intact. There are 5 additional cases in which the posterior part of the ring was broken along with the anterior part, but not falling in the groups spoken of as Malgaigne fractures. Thus, the common fracture of the pelvis is through the anterior half of the pelvic ring. The horizontal ramus of the pubis were fractured in 23 instances in our series, while in the remaining 5 cases there was a separation of the symphysis or a fracture through the pubis proper. In the fractures of the anterior part of the pelvic ring with displacement, there must of necessity be some change in contour in the posterior part of the ring. When there is no accompanying posterior fracture, the bend in the ring must take place at the sacro iliac joint. The injury to these ligamentous attachments probably is not overcome so easily as a bony injury. This doubtless accounts for the back pain of which the patients often complain in the first few months of their convalescence.

When the horizontal ramus of the pubis is broken without other injury, there is likely to be little or no displacement

ever, 44 per cent are women. Sixty per cent of the nonindustrial cases are women. This is no doubt due to the fact that the female pelvis is more frail than the male pelvis and is broken with less force. In our series, there were three fractures which occurred in women as the result of minor injuries such as falling out of bed or tripping over a rug.

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A careful physical examination is usually very instructive however, and x ray examination is necessary to determine the exact and complete bony injury. When the patient is first admitted to the hospital the diagnosis of the complication is often more important than the diagnosis of the fracture. If the patient is severely hurt an examination for tenderness and crepitus should not be made for fear of increasing the shock.

When the pelvis is fractured, there is seldom only one fracture line. In our series of 60 acute cases, 80 per cent had more

When this is done, or if the pelvis should be manually compressed with the patient under anesthesia, the urethra should be held well posteriorly by means of a sound³ In resistant cases, the symphysis has been wired successfully³ We have never found this to be necessary

Fractures through the posterior part of the ring are best treated by means of the canvas sling with a wooden spreader *This apparatus is frequently used as a routine procedure in all cases of fracture of the pelvis*¹³ Traction may or may not be used in association with this When traction is used it is employed for six to eight weeks No weight bearing is allowed for twelve weeks Hard labor is advised against for six months

FRACTURES OF SINGLE BONES NOT INVOLVING THE PELVIC RING

These are probably the least serious of fractures of the pelvis As a rule, they are serious only in so much as they are accompanied by associated injuries or complications There were 10 cases in this series These were equally divided between fractures of the ilium and fractures of the ischial arch, including the ischium and the descending ramus of the pubis The latter fractures usually occur as a result of falling in the sitting position Fractures of the ilium are due to direct force or muscle pull as in the case of the spines of the ilium

Fractures of the ilium are treated by rest in bed for three or four weeks When there is a fracture of one of the spines, the affected muscle should be relaxed by the position of the thigh If there is a large piece of bone pulled off with the muscle attachment, it may be nailed in place¹⁴ This is not necessary to a good positional result In fractures of the wing of the ilium, treatment by the canvas sling will increase the pain and deformity⁸

In the treatment of ischial fractures the patient should not sit erect, thereby bearing weight on the ischium, for six or eight weeks If sitting is necessary the weight may be borne by the other side Standing is not harmful

FRACTURES OF THE ACETABULUM

These may be divided into 3 groups

- 1 Fractures of the rim of the acetabulum

When there is displacement, there is an associated fracture of the descending ramus of the pubis or of the ischium. These fractures may usually be diagnosed by rectal or vaginal examination.

If there is no deformity, the patient may be placed flat in bed or on a Bradford frame for eight weeks with a satisfactory result. If there is any fear of lack of cooperation on the part of the patient, a plaster cast had best be applied to prevent his sitting up in bed and producing deformity. The failure to take this precaution accounted for one of the poor results in this series. It is of course easy to say that the patient has only himself to blame if he sits up in bed against orders. Nevertheless, the patient will only remember that he was under your care and that he got a poor result. In fracture of the horizontal ramus only, without a fracture of the descending ramus of the pubis or of the ischium, there is no danger of displacement during convalescence.

When the complete fracture of the anterior part of the pelvis occurs (including both the horizontal ramus of the pubis and the descending ramus of the pubis or of the ischium) there is usually some deformity requiring reduction. This is best accomplished by traction. The lateral fragment is most often displaced

tion appa
skeletal tr
adequate
reduction

maintained by plaster boots from the knees down with a bar across the ankles. The Roger Anderson well leg traction apparatus would probably give a good result.

When there is a fracture with lateral displacement or a separation of the symphysis pubis the treatment of choice is by means of a canvas sling.¹³ The amount of lateral pressure may be regulated by a wooden spreader. If the sling is used with no spreader at all it must be watched carefully for fear of pressure sores over the greater trochanters. If the separation of the symphysis cannot be closed by this method skeletal

When this is done, or if the pelvis should be manually compressed with the patient under anesthesia the urethra should be held well posteriorly by means of a sound³ In resistant cases, the symphysis has been wired successfully³ We have never found this to be necessary

Fractures through the posterior part of the ring are best treated by means of the canvas sling with a wooden spreader This apparatus is frequently used as a routine procedure in all cases of fracture of the pelvis¹³ Traction may or may not be used in association with this When traction is used it is employed for six to eight weeks No weight bearing is allowed for twelve weeks Hard labor is advised against for six months

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FRACTURES OF THE ACETABULUM

These may be divided into 3 groups

- 1 Fractures of the rim of the acetabulum

- 2 Fractures or epiphyseal separation of the floor of the acetabulum
- 3 Penetrating fractures of the floor of the acetabulum with or without intrapelvic displacement of the head of the femur

Fractures of the rim of the acetabulum are usually the result of a posterior dislocation of the femur. The diagnosis is to be suspected in these cases, but is rarely made without the aid of an x ray examination. Care must be taken not to confuse

result

The differentiation in the remaining two groups is a matter of degree, but is of considerable importance in treatment and prognosis. The injury is almost always sustained by a blow on the greater trochanter. There have been cases reported however, where the force was transmitted through the femur.¹³ When there is a fracture of the floor of the acetabulum without displacement the fracture may be suspected by the elicitation of pain on pressure over the greater trochanter. Treatment in a plaster cast for four weeks with rest in bed for eight weeks is satisfactory. There should be no weight bearing for three months.

A penetrating fracture of the acetabulum may be indicated by a diminution of the prominence of the greater trochanter. If there is a complete intrapelvic displacement of the head of the femur, it may be felt by rectal examination. In these cases with displacement, reduction is necessary. This may be obtained under general anesthesia but is frequently difficult to maintain. Skeletal fixation has been recommended¹⁴ by placing a pin through the greater trochanter and incorporating it in the cast.

Reduction may be obtained by gradual traction. Longitudinal traction by means of a Russell traction apparatus and lateral traction with the Ruth Maxwell apparatus may be sufficient. If more traction is needed than can be obtained by this method, skeletal traction may be applied through the greater trochanter by the use of a pin.¹⁴ Cubbins has placed a screw in the greater trochanter for this purpose.⁴

THE DOUBLE VERTICAL FRACTURE OF MALGAIGNE

This is the fracture in which the pelvic ring is broken both anteriorly and posteriorly on the same side. Thus, one half of the pelvis may be displaced on the other. This fracture is usually the result of a severe force against one half of the pelvis. If there is no displacement the patient may be kept flat in bed or treated in a canvas sling. If there is displacement, the deformity must be corrected. A considerable amount of traction is usually needed, but skin traction is occasionally satisfactory. Skeletal traction by means of the well leg traction apparatus has proved satisfactory,¹⁰ since it is a problem of pulling one side of the pelvis down and pushing up on the other until the two meet. Although a great deal of traction may be required for reduction, the amount required to maintain reduction is not great. Skeletal traction by a wire through the ischium has been advised.¹² These cases are always the result of severe injury so that shock is usually great.

COMPLICATIONS AND ASSOCIATED INJURIES

The mortality in cases of fracture of the pelvis is due to the complications and the associated injuries. There were 5 deaths in the present series. Three of these were due to fractured skulls with cerebral injury. One died of shock and internal hemorrhage a few hours after a 5 ton truck ran over his pelvis. The other died a few hours after an operation for a ruptured small intestine.

Shock is the complication requiring first attention upon admission to the hospital. If the patient is already in shock he must be treated energetically. If he is not yet in shock every measure must be taken to prevent it. The shock is caused not only by the fractured pelvis but by the associated injuries. These injuries must, of course, be treated irrespective of the fractured pelvis. The associated injuries in the reported series are listed as follows:

Fracture of one or more long bones	14
Fracture of the skull	5
Cerebral injury without fracture of skull	4
Fracture of one or more vertebrae	5
Dislocation of the femur	2
Ruptured kidney	1
Ruptured small intestine	1

Rupture of the urethra and bladder are complications which require emergency treatment. These complications have occurred once and twice respectively in this series. There were 2 cases operated upon because of lower abdominal masses. In each instance it proved to be a preperitoneal hematoma.

Rupture of the rectum and vagina are rare. None occurred in this series. Rupture of the urethra should be suspected when there is a separation of the symphysis or a fracture near the midline anteriorly. In such a case, the patient should be catheterized before he attempts to void. This will prevent the spilling of urine in the perineal tissues. If a catheter cannot be passed the diagnosis is obvious. The patient should be operated upon immediately by the perineal approach and the urethra repaired over a catheter. If there is difficulty in finding the proximal end of the urethra the bladder should be opened and a retrograde urethral catheterization done. One should not be satisfied with a cystostomy since late repair of the urethra is difficult and may be impossible.

If the fracture of the pelvis is not near the midline anteriorly, the patient may be allowed to void. If there is a ruptured bladder there may be an urgent desire to urinate or a small amount of bloody urine or none at all may be expressed. The rupture of the bladder may be intraperitoneal or extraperitoneal. In 53 cases, Campbell¹ found 34 to be intraperitoneal and 21 extraperitoneal. In our reported series there were only 2 ruptured bladders; both lacerations were extraperitoneal. When the rupture is intraperitoneal there will be evidence of peritoneal irritation requiring that the abdomen be opened. In that event, operation may be performed without the necessity of making a positive preoperative diagnosis of just which viscus is ruptured. If the rupture is extraperitoneal there will be suprapubic tenderness and swelling. Some¹⁸ advocate doing

catheter
exposed

for suturing a good result may be obtained by passing a catheter in the bladder through the urethra and draining the area around the rupture.

When there is a question as to whether or not the bladder is ruptured it has been our custom to instill a measured quan-

tity of sterile solution and then try to recover it. There are some who feel that this procedure is unjustifiable. They¹⁴ point out that the test may give misleading information and that if there is a rupture it spreads fluid and probably infection throughout the tissues. The error in this test is likely to be due to a small hole in the bladder through which the fluid will not escape except under pressure. Thus if the test is negative with a small amount of fluid the bladder is distended with 400 or 500 cc. of fluid for about five minutes. This will probably allow some fluid to escape and prevent misleading information. It has been our feeling that it is better to take the risk of allowing the fluid to diffuse through the tissues than to operate upon patients not requiring surgery. Jones and Buckner⁸ feel that the injection of air is less harmful and more informative. Conway² has injected opaque solutions into the bladder and taken diagnostic x rays.

Paralytic ileus is a frequent troublesome complication. Weil *et al.*¹⁵ in a series of 28 fatalities reported paralytic ileus the cause of death in 8 instances. In the treatment of the reported cases it has been the custom to give pitressin promptly if there is any evidence of distention. Paralytic ileus developed to a serious degree in only 2 instances; one patient died but had other injuries sufficient to account for his death.

Injury to the great vessels of the pelvis probably accounts for some of the deaths which occur soon after accidents. Because of this a diagnosis is not made with certainty unless an autopsy is performed. As a result this complication is seldom reported. It was probably the cause of death in 1 of our cases.

Nerve injuries were reported in 9 per cent of 100 cases reported by Lam.⁹ In the present series nerve injury was recognized in only 3 instances. In other series however nerve injuries have been reported in 33 per cent of central dislocation fractures, obturator pain in 20 per cent and peroneal palsy in 13 per cent.

RESULTS

Although the series is small and the follow up is inadequate some information may be gained by studying the results in the cases followed. The patients have been divided into 4 groups according to the result when last seen. In some instances the time interval was so short that the patient had

obviously not reached his final status. In group A are those patients who were perfectly well with no complaint and no deformity. Group B includes those patients who are working at their regular occupations, but still have some sacro iliac discomfort on bending sitting or the like. Listed here also, are those patients who have no complaint, but who have a slight limp because of some shortening or limitation of motion. In group C are those patients who, while up and about have enough pain or limping to prevent a return to their former occupations. In group D are patients who when last seen could not walk without crutches. It should be noted as pointed out below that some of these patients with poor results had only gone a few months since the accident. Time has doubtless proved beneficial to many of them.

	Total	Died	Followed	Result			
				A	B	C	D
Fractures of pelvic ring	31	1	20	15	3	1	1
Fractures of single bones	10	0	6	6	0	0	0
Fractures of acetabulum	8	0	3	2	2	0	1
Double vertical fractures	6	1	5	2	3	0	1
Unknown	5	3	2	2	0	0	0
Total	60	5	38	27	7	1	3

Twenty of the patients with fracture of the pelvic ring were followed. Excellent results were obtained in 15 of these. The patients had absolutely no complaints when last seen. Three were placed in group B. These patients had been followed

moderate limp. She still could not walk without crutches three months following discharge from the hospital.

In fractures of single bones without involvement of the pelvic ring the results were excellent as was to be expected. The patients followed had no complaints or loss of function.

Fracture of the acetabulum is a severe injury. It has been stated that they all get ankylosis of the hip joint.⁴ That has

not been our experience⁶ Five patients in the present series were followed Four of these had an excellent result although 2 of these were placed in group B because of a slight limp due to limitation of motion at the hip The other patient had bilateral acetabular fractures and could not walk alone when seen four months following discharge

The double vertical fracture of Malgaigne is a severe injury but the results are unexpectedly good if a proper reduction is obtained Of 5 patients followed 2 obtained perfect results Two others were back at work when last seen four and four teen months following discharge from the hospital but complained respectively of pain in the back on sitting a long time or bending over The fifth patient was unable to walk alone four months following discharge

SUMMARY

Sixty cases of acute fracture of the pelvis are reviewed Two thirds of the fractures were due to civilian accidents and one third to industrial accidents Sixty per cent of the civilian accidents occurred in women There were 5 deaths due to associated injuries or complications Seventeen cases were not followed as to the end result Of the 38 cases followed 71 per cent obtained a perfect result An additional 18 per cent were able to return to former activity but had some residual deformity or sacro iliac discomfort The remaining 11 per cent were still in the poor result group when last seen

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obviously not reached his final status. In group A are those patients who were perfectly well with no complaint and no deformity. Group B includes those patients who are working at their regular occupations but still have some sacro iliac discomfort on bending sitting or the like. Listed here also are those patients who have no complaint but who have a slight limp because of some shortening or limitation of motion. In group C are those patients who, while up and about have enough pain or limping to prevent a return to their former occupations. In group D are patients who when last seen could not walk without crutches. It should be noted as pointed out below that some of these patients with poor results had only gone a few months since the accident. Time has doubtless proved beneficial to many of them.

	Total	Died	Followed	Result			
				A	B	C	D
Fractures of pelvic ring	31	1	0	15	3	1	1
Fractures of single bones	10	0	6	6	0	0	0
Fractures of acetabulum	3	0	3	2	2	0	1
Double vertical fractures	6	1		2	3	0	1
Unknown		3	2	2	0	0	0
Total	60	5	15	27	1	3	

Twenty of the patients with fracture of the pelvic ring were followed. Excellent results were obtained in 15 of these. The patients had absolutely no complaints when last seen. Three were placed in group B. These patients had been followed three, four and nine months since discharge from the hospital. While they were back at their former activities they were still bothered by sacro-iliac discomfort upon bending over or sitting for a long time. One patient was placed in group C who at three months had moderate sacro-iliac pain and walked with a moderate limp. One patient was placed in group D because she still could not walk without crutches three months following discharge from the hospital.

In fractures of single bones without involvement of the pelvic ring the results were excellent as was to be expected. The patients followed had no complaints or loss of function.

Fracture of the acetabulum is a severe injury. It has been stated that they all get ankylosis of the hip joint.* That has

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FRACTURE OF UPPER THIRD OF HUMERUS

FRACTURE of the upper third of the humerus is a frequent fracture in both sexes during all adult years. In children, it is extremely rare, though epiphyseal injuries about the shoulder frequently occur. Just why the epiphyseal injuries outnumber the fractures here while the opposite occurs at the wrist within the same age groups has never been quite clear to me. In spite of a large experience, I still feel that dislocation of the lower radial epiphysis should be a more common accident than Colles fracture in children.

Fractures of the upper third of the humerus, like all other fractures, are caused either by direct or indirect violence. The direct violence is easy to understand, but the indirect violence, described as a fall on the outstretched hand is much harder for me to interpret.

This, I think, dates back to undergraduate days, when I was rather startled by the number of fractures caused by a 'fall on the outstretched hand'. It seemed to me then, and even now, that too frequently we are satisfied with this mechanism as the sole explanation of indirect violence for every dislocation and fracture from phalanx to clavicle.

Of course the degree of rotation of shoulder and of fore arm, the degree of flexion of wrist, strength and tone of muscles at times of accident, all enter into the determination of what must give. These factors are rather hard to analyze because of the short time involved and the pain caused by the accident.

In this brief discussion, I will not be concerned with the so called "pathologic fractures," where the force and direction of the trauma are the least important factors and in which the

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Fig 409—Fracture of greater tuberosity with dislocation of head of humerus



Fig 410—Same case as Fig 409 after reduction of head of humerus. Fractured greater tuberosity in proper position

The first of these concerns fractures associated with dislocation of the head of the humerus and those in which the complication of dislocation does not exist

resultant relationship of the fracture fragments does not have its usual importance

Likewise, the fractures in this part of the anatomy resulting from gunshot wound will have to be passed over. In these cases, the complicating factors of infection, soft tissue



Fig 407—Fracture of greater tuberosity with dislocation of head of humerus



Fig 408—Same case as Fig 407 after reduction of head of humerus. Fractured greater tuberosity in proper position

loss, bone loss and nerve injury make each case an individual problem to be met by general surgical principles rather than by some definite fracture procedure.

To simplify the diagnosis and management of these fractures, it is essential to make several broad classifications.



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To simplify the diagnosis and management of these fractures, it is essential to make several broad classifications

The treatment of fracture of greater tuberosity where displacement has occurred is to dress the arm in 90 degrees



Fig. The displacement of fracture fragment apparently the same as in Fig. 409. tuberosity

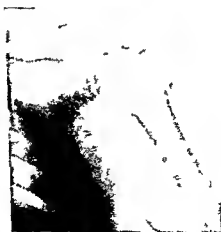


Fig. 412—Same case as in Fig. 411. Head of humerus has been replaced but the fractured greater tuberosity remains below its normal position—in contrast to Fig. 410.

abduction with external rotation of 180 degrees. The elbow is flexed at right angle to the arm so that the hand is slightly

In all cases of fracture of upper third of humerus associated with dislocation of the head of humerus, the dislocation should be reduced before attempting to treat the fracture

When dislocation complicates simple fracture of the upper third of humerus, the fracture may be one of three types—fracture of greater tuberosity, fracture of lesser tuberosity, or fracture of the surgical neck. Of these complications, the first is the simplest, as complete reduction of the dislocation usually causes complete reposition of the fracture fragments (Figs 407-410)

Until recently, I would have said that reduction of dislocation always reduced the fracture of the greater tuberosity, a short time ago, however, I had to perform open reduction of a fracture of greater tuberosity to remove interposed deltoid muscle fibers even though we had x ray evidence of complete reduction of the dislocation of the head. When fluoroscopic attempts to reduce this fracture were unsuccessful I had to interfere surgically. Other such cases have been reported and each of the illustrations showed that the greater tuberosity was displaced downward. This of course is opposite to the displacement commonly produced by the tendon attachments and contrary to the deformity usually found (Figs 411-412)

In this particular case, it was necessary not only to remove the muscle fibers from the fracture site, but to elevate the tuberosity and hold it in place with a bone screw

The symptoms in these cases of dislocation with fracture of the greater tuberosity are primarily those of dislocation with pain tenderness arm supported by the patient and loss of deltoid prominence. For the sake of the patient and as a legal safeguard to hospital and physician no dislocation should be replaced before obtaining an x ray record

Too frequently reductions have been attempted in cases of fracture either of the surgical or the anatomical neck when no dislocation existed. x Ray taken after attempted reduction and revealing fracture line for first time raises the malpractice question of the physician having produced the fracture during manipulation

The symptoms after reduction of the dislocation are tenderness over the tuberosity and disinclination to attempt abduction of the arm

three to four weeks. The position most satisfactory is with the arm in abduction of 90 degrees to the long axis of body, forearm flexed on arm, and the whole arm internally rotated. This brings forearm with palm toward body in the position of akimbo, where elbow is the apex of triangle with the base formed by the chest wall.

This position should be maintained for three to four weeks, and that is best done by dressing the arm and forearm over a Middeldorpf's triangle. This triangle may be made of any



Fig. 413.—Fracture of surgical neck of humerus with rotation of the head to such a degree that synovia covered portion of head is in contact with the exposed spongy fracture line of the shaft.

heavy cardboard with one side equal to length from wrist to elbow, one from elbow to axilla, and the third from axilla to top of crest of iliac bone. This is amply padded, placed in position and then triangle, arm, forearm and body incorporated in plaster of paris. This position is quite comfortable and less conspicuous than many plaster dressings.

Fracture of the surgical neck of the humerus associated with dislocation of the head frequently occurs and may prove very troublesome. Occasionally it is necessary to expose the fracture site surgically and reduce the head, occasionally the

above head level and forearm parallel to long axis of the body. The forearm is more comfortable in midrotation with palm toward side of face.

This position, sometimes called the lighthouse position, is best maintained by properly applied plaster of paris cast to the body, arm and forearm. The weight comes on the posterior aspect of the abducted arm and lateral wall of the chest, so that ample padding should be used to avoid pressure disturbances.

The position should be maintained from four to five weeks.

Fracture of the lesser tuberosity occasionally occurs with dislocation of the head of humerus. The causative trauma in these cases is usually forcible external rotation of the arm.

The symptoms are again predominantly those of dislocation with the additional subjective complaint of marked pain on least attempt to move the arm. The patient also is apt to report that at the time of accident something snapped and the pain became more acute.

The treatment consists of replacing the dislocation first. Though not truly part of this discussion, I believe a word as to the method of reduction may prove helpful.

The patient is first x rayed, then put flat on his back on low table or examining bench. Pain is controlled by hypodermics, nitrous oxide and oxygen ether or brachial plexus block. The arm with extended forearm is then abducted and by firm grasp about the wrist is extended from the body. Countertraction by an assistant is preferable to the stocking covered foot against the chest wall. The arm is gradually brought down to side of body and assistant guides the head over brim of glenoid fossa with his fingers instead of using foot as fulcrum. This is less apt to cause fracture and soft tissue injury and in case of already existing fracture less trauma occurs. Frequently traction may be done by an untrained assistant and the physician's hands kept free for the axillary manipulation. When necessary to work unassisted, a cinch may be applied about the wrist of the patient and then about the waist of the physician. Since adopting the hand guiding technic, I have found little use for the better known and older methods so frequently described.

After reduction of the dislocation, the treatment of fracture of lesser tuberosity is to maintain immobilization from

dislocation of the head, occur in the same locations previously described, and also in the anatomic neck and upper portion on the shaft

In the fracture of greater tuberosity, lesser tuberosity and surgical neck without dislocation of the head and with separation of the fragments, the dressings are the same as have just been described

The fractures through the anatomic neck usually occur in middle life. Diagnosis before x ray is usually difficult, but upward pressure on the bent elbow which gives pain under the deltoid should arouse suspicion

If the fracture site is impacted and the patient old it is advisable to leave it alone. It is protected by a pad in the axilla down to the internal condyle, and a plaster of paris shoulder cap on the outside of arm. The forearm should be kept in sling and sling fixed to trunk to prevent rotation outward at the fracture site

This position is maintained from five to six weeks though elbow, wrist and finger motion is encouraged after two weeks. When cap is removed, shoulder motion can be more rapidly regained by having the patient lean forward allow the arm to swing free and then bend sideways so that the arm hangs free in abduction

This whole procedure is to obtain function rather than anatomic perfection in the older patients

In the younger patients with fragments in poor position, the impaction is broken up, and the arm is then dressed in abduction of 90 per cent and external rotation of 90 per cent. This position should be maintained for three weeks and then mild active motion encouraged

Fracture of the shaft above the junction of the middle and upper thirds of the humerus with fragments in poor position is usually caused by direct violence. The symptoms of pain, fixation of arm to side by the opposite hand, and visible deformity suggesting angulation outward, help in the diagnosis prior to x ray. Even without deformity, three sided tenderness can be elicited at site of fracture

If manipulation and replacement cannot be maintained by dressing in the aeroplane position the patient should be hospitalized traction in abduction maintained for ten days to over-

head cannot be readily reduced and then surgical intervention is necessary to get end to end approximation

A frequent finding after reduction is that the head is rotated in such extreme abduction that the fractured end of shaft is against synovial covering of the head and proximal fracture line is against under surface of the deltoid muscle (Fig 413)

Many times I have seen the head removed, or about to be removed for this complication, when traction of the arm at right angles to the body maintained for seven to ten days will bring the two fracture surfaces into contact. This, of course is not a satisfactory ambulatory treatment, and calls for hospitalization where x ray check up with portable apparatus is available. Once the fracture lines are in approximation, either immediately or after traction has restored the position, the arm is dressed in 90 degree abduction and 90 degree external rotation—the so called 'aeroplane position'. Since aeroplane splints are so readily available the plaster dressing in Osgood Penn Hallow position is seldom mentioned, and yet is the frequently used body cast with arm cast at right angle to the body.

A simple method of obtaining this position is to make a cardboard triangle (Middeldorps). The width of cardboard is the width of the right angle arm splint. The lengths of the sides are equivalent to length from elbow to axilla axilla to top of crest of ilium and then from there to elbow with arm at right angles. This triangle is attached to the short bar of a wooden right angle splint and the whole well padded. All measure

but the

muscle tone may be maintained

One of the advantages of this type of dressing is that it can be made immediately, and another possibility is that x ray cassettes can be cut from cardboard to fit the opening in the triangle. In this way a second position view of fracture site can frequently be obtained early in the treatment.

Fractures of the upper third of humerus not associated with

If function does not return soon after injury, nerve suture may be necessary. With symptoms coming on later, and gradually getting worse, the nerve must be freed from the cal-



Fig 416—Patient with epiphysis of head of humerus ununited, with fracture of surgical neck of humerus. Head remained in glenoid fossa and shaft was forced upward.



Fig 417—Same patient as in Fig 416. Traction has been applied and arm dressed in 90-degree abduction. Complete reposition of fragments.

lus, and protected from future involvement by changing its course.

To this time, with one exception, we have considered only the fractures with displacement. In the same order, let us

come muscle spasm and the arm then dressed in 90-degree abduction and 90 degree external rotation (Figs 414-417)

Nerve injury may occur in fractures of this position of the humerus. High up the circumflex may be injured or involved



Fig. 414—Poor position of fragments of fracture of upper portion of shaft of humerus

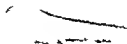


Fig. 415—Same

Position improved

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lus, and protected from future involvement by changing its course.

To this time with one exception, we have considered only the fractures with displacement. In the same order, let us

consider fractures without displacement and not associated with dislocation of head of humerus

Fracture of the greater tuberosity may occur from direct violence and not be associated with displacement (Fig 418) In either case there is tenderness over the fracture site, pain on motion of the supraspinatus tendon and the description of pain suggests acute so called "subdeltoid bursitis"

The treatment in this type of case is simple fixation of the arm to the side of the body As a further protection to the



Fig 418—Fracture of greater tuberosity with no displacement

sling and is frequently removed for exercise of the elbow joint Immobilization for three to four weeks is usually sufficient

Concerning the molded plaster of paris shoulder cap it might be appropriate to describe a variation in making molded splints Whether for shoulder cap forearm internal right angle splint or laterals of the lower extremity I use the same technique The desired design is cut out of double thickness cotton lint sometimes called "surgical lint" The fuzzy surface is turned in the design is then laid flat and rolled plaster of paris bandages are worked back and forth over it until the necessary thickness is obtained In this step the only parts of the design which are important are the greatest length and

greatest width. These are the dimensions then of a rectangle of plaster. When necessary thickness is obtained, the plaster is turned over, bringing the lint design on top. All extra plaster showing beyond the lint is then cut rapidly away. The double layer of lint is then opened up, and folded over the exposed surface of the plaster. This gives up two layers of lint with fuzzy surface out—in between these layers is the plaster. This is applied to the part, molded into shape by the fixation bandages. No exposed plaster can be seen or felt, and crumpling is reduced to a minimum.



Fig. 419. Fracture of both greater tuberosity and upper end of shaft without displacement. Case was dressed with axillary pad and plaster shoulder cap.

Fracture of the lesser tuberosity, in good position is also dressed with the arm down along side of the chest with thin axillary pad and plaster shoulder cap. In this case however, internal rotation is maintained for three weeks before permitting liberty.

Fracture of the anatomic neck, either in good position originally or after an impaction is broken up, may be dressed the same way as long as good position is maintained. If upper fragment or head has a tendency to rotate into external rotation then the arm must be dressed in enough abduction to bring the fractured surfaces into opposition.

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Fracture of the greater tuberosity may occur from direct violence and not be associated with displacement (Fig 418) In either case there is tenderness over the fracture site, pain on motion of the supraspinatus tendon and the description of pain suggests acute so called "subdeltoid bursitis"

The treatment in this type of case is simple fixation of the arm to the side of the body As a further protection to the tender fracture area, I like the use of a molded plaster shoulder cap This is fastened about the body, fixing a small pad between chest wall and humerus The forearm is carried in a



Fig 418—Fracture of greater tuberosity with no displacement

sling and is frequently removed for exercise of the elbow joint Immobilization for three to four weeks is usually sufficient

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turned in, the design is then laid flat, and rolled plaster of paris bandages are worked back and forth over it until the necessary thickness is obtained In this step the only parts of the design which are important are the greatest length and

Occasionally a tongue depressor picket fence is incorporated in the dressing

The error of applying an internal right angle splint to these cases still happens occasionally. As this increases the danger of displacement its use should of course be discouraged



Fig. 422—Fracture of surgical neck with shaft driven into head producing many fragments



Fig. 423—Same patient as in Fig. 422 after traction and application of plaster

Fractures of the head of the humerus itself usually occur from indirect violence. The fracture is usually one of two types—first a small fragment of cortex broken off or else two pieces caused by the shaft being driven upward into the head (Figs 421–425)

The fractures of surgical neck in good position may also be dressed over axillary pad and with shoulder cap as long as good opposition is maintained



Fig 420—Fracture of upper end of shaft of humerus with displacement of fragments



Fig 421—Fracture of surgical neck of humerus with shaft driven into head fracturing only a small fragment off the head

Fractures of upper end of shaft in good position may be dressed in 90-degree abduction if desired but wherever it has been possible to maintain apposition I have used a thick axillary pad and plaster shoulder cap (Figs 419 420)

In delayed union, the use of physiotherapy, occupational therapy, more motion at fracture site, and careful metabolic supervision may hurry the healing

In nonunion, sliding grafts are practically impossible, so lateral bone splints are preferable. The use of metal splints in true nonunion has not been physiologically sound, but metal strips of various kinds to stimulate callus may soon correct that fault

When necessary to do an open reduction and insert a plate or band, I do not count on operating again to remove the plate and screws. As the plate is used only as an aid to alignment, and then the arm dressed in muscle equilibrium so that no stress is exerted on the screws, I have not seen the necessity of second operation in clean cases. Though various mechanical devices are rapidly replacing older methods, and in many cases improving results, the upper third of the humerus has not lent itself very well to what Bohler calls gadgets. Recently Roger Anderson has advocated half pins and plaster cast for upper third of shaft fractures but it will probably take a long time before it will be generally adopted

As important as the immediate treatment is the treatment after two weeks and after casts, appliances and dressings are all removed. No matter how perfect the bone result, unless the patient has restoration of shoulder motion the treatment has not been efficient

Of the various adjunct therapy measures I have found well supervised occupational therapy the most valuable. For loosening the shoulder, crawling up the wall with the hand on the injured side is an uninteresting exercise—so is the forward and abduction obtained by body flexion, but weaving a circular

ward his work instead of toward his pain

In none of the cases where the head of the humerus had to be removed, have I seen enough abduction to warrant the consideration of that therapeutic measure except under most extreme circumstances

Functional restoration is usually poor, especially in the latter type. In younger patients, open reduction and reposition of fragments is to be recommended if traction in abduction does not give complete reduction.



Fig. 424.—Badly comminuted fracture of head of humerus caused by shaft being driven into it.



Fig. 425.—Same patient as in Fig. 424 after traction and application of plaster.

the older the patient the less the
stiff shoulder frequently results

6 9 3 45 4

In delayed union, the use of physiotherapy, occupational therapy, more motion at fracture site, and careful metabolic supervision may hurry the healing

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Of the various adjunct therapy measures I have found well supervised occupational therapy the most valuable. For loosening the shoulder, crawling up the wall with the hand on the injured side is an uninteresting exercise—so is the forward and abduction obtained by body flexion but weaving a circular rug on a bicycle wheel like frame can be made most interesting. Like all occupational therapy, the increase of motion occurs in the damaged joint while the patient's attention is directed toward his work instead of toward his pain

In none of the cases where the head of the humerus had to be removed, have I seen enough abduction to warrant the consideration of that therapeutic measure except under most extreme circumstances



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FRACTURES OF THE CARPAL SCAPHOID

Of all the fractures that pass unrecognized for days or even weeks, fractures of the carpal scaphoid and epiphyseal separations of the lower radius probably head the list. In almost every case the trauma results from acute dorsiflexion of the wrist, as from a fall on the outstretched hand. Because of the absence of marked displacement and swelling the injury is looked upon as a 'sprained wrist'. It is only when the discomfort and disability do not disappear that the patient comes for medical attention. This is often one to two weeks after the fracture has taken place.

In 10 of 25 cases of fracture of the scaphoid the first treatment was not given until one week or more after the fracture had occurred. This delay in the diagnosis and treatment prolongs the periods of disability and then decreases the chances of union.

The delay is not always the fault of the patient. It may occur because the physician who first sees the patient is not familiar with the signs and symptoms of scaphoid fractures. Swelling is usually slight, but there is pain on moving the wrist, especially on dorsiflexion, and on pressure in the anatomic snuff box. Tenderness is present, more marked on the dorsum of the wrist on the radial side. The sign most helpful in making a differential diagnosis is the demonstration of pain by pressure or percussion on the fingers and thumb in their long axes. With the fingers and thumb held in full extension, pressure or percussion toward the wrist will give increased pain at the frac-

of formation of blood clot invasion and organization by newly formed thin walled blood vessels development of fibrous tissue



Fig 426 Fracture of the tubercle of the scaphoid March 12 1937



Fig 427—Same patient as F 426 June 3 1937 after immobilization and cast
These fractures always unite and give good functional results

in which osteoblastic elements appear transition into osteoid tissue leading to truly formed trabecular osseous structure'

ture site when pressure is made on the thumb or index finger. Little pain is experienced by pressure on the other fingers, and finger pressure usually does not cause any increase in pain in simple sprains. The demonstration of the above findings should certainly warrant a roentgen examination of the wrist.

The roentgen film is helpful not only in confirming the diagnosis. It is also important in deciding upon the treatment and in estimating the prognosis. The reasons for this are obvious if the anatomy of the scaphoid bone and the course of fracture healing in these bones are considered.

The scaphoid, like the other carpal bones, is largely covered by articular cartilage. There is little definite periosteal covering and the blood supply to the bone, which is so important in fracture healing, arises from two tiny vessels. These vessels were demonstrated by injections by Lexer.¹ One enters the tubercle of the scaphoid at the attachment of the carporadial collateral ligament and the other enters the bone at its mid-portion to send radiating branches to the body of the bone. Since fracture healing is largely dependent upon an adequate blood supply, the site of the fracture as demonstrated by the roentgen film has a very definite bearing upon the prognosis and treatment. A fracture of the tubercle of the scaphoid, which is extra-articular and where each fragment has a nourishing vessel, will almost invariably unite in a fairly short time if adequately immobilized (Figs. 426-427). So also will in complete transverse fractures where at least some vessels on each side of the fracture line probably remain intact. In complete transverse fractures, however, where the fracture occurs at about the position of the entrance of the nutrient artery into the body of the bone, the blood supply to one or both fragments may be very inadequate. It is for this reason that union is slow and the prognosis must be guarded. Prolonged and complete immobilization is necessary in order to permit a redevelopment

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union must take place from the cancellous bony tissue of the
and that there

of formation of blood clot, invasion, and organization by newly formed thin walled blood vessels, development of fibrous tissue,



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These fractures always unite and give good functional results

in which osteoblastic elements appear, transition into osteoid tissue leading to truly formed trabecular osseous structure”

with 1 or 2 very wet circular bandages which should include the metacarpal of the thumb. The wet plaster can be carefully molded to fit exactly the contours of the part. It is important that the molding should make the plaster fit accurately the concavity in the palm otherwise the immobilization of the metacarpals is incomplete when the patient uses his fingers. The plaster should extend to the heads of the metacarpals in the dorsal surface, but should be trimmed on the palmar surface and in the web of the thumb to permit full flexion of the fingers. The distal phalanx of the thumb should be allowed full range of motion but not the metacarpal. When the cast has been properly applied and molded the metacarpals should not



FIG 428—Cast for immobilization of fracture of carpal scaphoid. Note that the cast includes the palm and metacarpal of the thumb.

pull away from the dorsal part of the cast with flexion of the fingers (Figs 428-430).

Such a cast provides complete and uninterrupted immobilization; it can be allowed to remain in place with ordinary usage for eight weeks or longer. What is more important, it permits active and almost normal function of the hand, which is by far the best method of stimulating the blood supply to the part. The fact that the patient has little inconvenience during the period of immobilization with the cast is of relatively minor importance as far as the treatment of the fracture is concerned. It is however of definite importance to the patient. Most patients can continue to perform their usual duties. Several of the patients reported below have played basketball and other sports while wearing the cast.

Boehler³ emphasizes the fact that callus formation can proceed only 'by new vessels growing from the spongy tissue of one fragment into that of the other. The least movement of the fragments upon one another must cut and destroy these newly forming vessels.' Nonunion can be prevented only by keeping the fracture fragments in complete and unbroken rest. The immobilization must be prolonged because there is relatively

transverse fractures the proximal 'radial' fragment retains its roentgen density by reason of the fact that its blood supply has been destroyed whereas the distal fragment shows decalcification for a time due to its increased vascularity. As fracture healing takes place and blood vessels invade the proximal fragment the two parts of the bone gradually return to the same degree of calcification. Decalcification is not necessarily a poor prognostic sign in scaphoid fractures and even in untreated fractures, union may be obtained in many cases if adequate immobilization is provided.

From a consideration of the above discussion of the anatomy and the course of fracture healing there are three factors which seem to stand out as important in the treatment. These are (1) complete and uninterrupted immobilization (2) immobilization of relatively long duration and (3) attempts to improve the blood supply to the fracture site. Reduction of the fracture rarely has to be considered because there is usually no displacement of the fragments. When there is a fracture dislocation of course reduction is a primary requisite in the treatment.

These factors may all be applied by the use of a nonpadded cast to the forearm wrist hand and thumb. The cast is applied

artial
very
the
wet 6 inch plaster bandage to the head of the metacarpals to the external epicondyle. The reduplication which can be made from 1 plaster bandage is cut longitudinally into 2 pieces which are applied to the hand and forearm front and back. The reduplications are held in place

In recent fractures the cast is allowed to remain in place for eight weeks. The only exception is in fractures of the tubercle where four weeks immobilization is usually sufficient. At the end of the eight weeks the cast is removed and a check up roentgenogram is made. If bony union is not complete a new cast is applied for an additional four weeks. Some of our patients refused to have a second cast even though the x ray film did not show union. Others left our hands before treatment could be completed and for this reason the prescribed regime could not be carried out. In spite of this many patients



Fig 431

Fig 432

Fig 431—Recent fracture of the body of the scaphoid. February 13, 1937.

Fig 432—Same patient as Fig 431. April 22, 1937, after immobilization in a cast. Note that the patient has perfect functional result although the line of fracture is still visible.

obtained good results with normal function, so that the question is raised as to whether immobilization is important after it has been applied without interruption for eight weeks (Figs 431-432). Will not the processes of repair continue without danger of interruption if guarded function be permitted after eight weeks fixation in a cast?

In old untreated fractures or those with nonunion the same treatment has been used. In 5 out of 6 cases a normally functioning wrist has resulted in spite of the fact that bony union was not shown by x ray (Figs 433-434). This raises the ques-

The cast should be applied as soon as the fracture is diagnosed. In recent fractures, there is usually not enough subse-



Fig. 429—Cast for immobilization of fracture of the scaphoid. Note the molding of the plaster to fit the concavity of the palm.

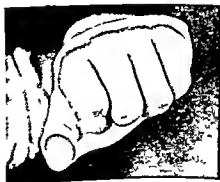


Fig. 430—Cast for fracture of the scaphoid. Note that the fingers can be used in almost full flexion; the head of the metacarpal remains in contact with the cast on the dorsum of the hand due to accurate molding of the cast in the palm.

quent swelling to cause constriction, although the patient should be carefully watched for several days to be sure that the cast is all right.

union when the cast was removed. These patients all have normal function without pain.

Old fractures 6. Of these, 2 were four months old, in patients who complained of continued pain and disability in the wrist. Normal function resulted from immobilization in a cast for eight weeks. Four patients had ununited fractures of more than a year's duration who came for treatment because of a recent recurrent injury to the wrist. In 3 of these patients, practically normal function was resumed without pain after immobilization in a cast. In 1 case there is continued pain and disability. This patient is an Italian with a compensation claim still pending.

SUMMARY

Union in scaphoid fractures is dependent upon the presence or development of an adequate blood supply to the fragments. The blood supply to the scaphoid is by two small nutrient arteries; there is practically no supply via periosteal vessels. The development of a blood supply adequate for fracture healing demands early, complete and uninterrupted immobilization for a period of at least six to eight weeks or even longer. The immobilization is best accomplished by the use of an unpadded cast applied to the forearm, wrist, hand and thumb. The cast, if properly applied, permits fairly good active function of the fingers and hand. In 18 of 19 recent fractures good results were obtained, although bony union was not obtained in every case. In 5 of 6 old fractures good functional results were obtained by the same treatment, although bony union was not obtained.

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tion as to whether the prolonged immobilization is not the factor that produces a clinical cure in the patients that are operated upon by bone pegging or drilling. Burnett⁴ reports excellent results from a bone pegging operation followed by eight to ten weeks of immobilization of the wrist. In only 1 of his cases, however, was he able to demonstrate bony union following operation.

The results obtained in the treatment of 26 cases of carpal scaphoid fractures may be tabulated as follows: patients aged

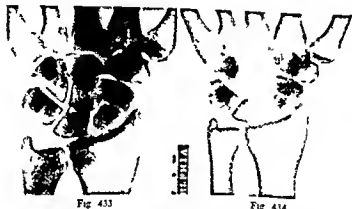


Fig. 433

Fig. 434

Fig. 433—Old fracture of the scaphoid with recent injury. January 18 1937

Fig. 434—Same patient as Fig. 433. March 12 1937 after immobilization in a cast. There is no evidence of bony union but there is perfect clinical result. This patient is now pitching ball with his injured arm without any disability whatever.

ten to twenty, 5 cases, twenty to thirty, 15 cases, thirty to forty, 2 cases, forty to fifty, 2 cases, fifty to sixty, 2 cases.

Males, 21, females, 5

Recent fractures, 20

Results: normal function without pain in 19 cases

One patient injured in an automobile accident was removed from our care by her lawyer. The cast was removed at the end of four weeks. She now has pain and tenderness over the scaphoid, and cannot lift anything heavy without pain. Her grip is poor. In 4 cases the roentgenogram showed no bony

CLINIC OF DR THOMAS J RYAN

FROM THE SURGICAL SERVICE OF THE MISERICORDIA AND
FITZGERALD MERCY HOSPITALS

THE RUSSELL EXTENSION

IN 1923 R. Hamilton Russell, of Melbourne, Australia described in the *British Journal of Surgery* his method of treating fractures of the femur. He directed attention to the importance of obtaining muscular equilibrium to secure alignment of the fracture. The requisites for the establishment of this equilibrium being a natural position of the limb, a comfortable support to the thigh, and proper application of adhesive skin traction. He also commented upon the rapidity with which union occurs in the presence of a balanced circulation and of the preservation of joint function coincident with this form of treatment. At this time we were using Buck's extension and a Thomas splint and these suggestions of Russell appeared to offer a greater opportunity to secure a good anatomic and functional result.

Our first patient, an adult male, weighing 190 pounds, was admitted with a transverse fracture of the middle of the shaft of the right femur, with overlapping of approximately 2 inches. After one week of extension with 7 pounds of weight we were very agreeably pleased to note that a complete reduction had been secured. This case convinced us that the mechanics of the extension were efficient. After two years a small group of cases was reported to the Philadelphia Academy of Surgery.

We have now used this treatment for fourteen years and have made some minor changes in the pulleys and overhead frame. These changes were made for convenience of application and do not in any manner attempt to alter the original technic described by Russell. We wish to present a description of the frame and pulleys and in addition record our experiences.

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The overhead frame shown in Fig 435 has been used in stead of the original frame described by Russell. It offers ease of application and can be readily changed to any position. The pulley on this frame is not quite as high as shown in the original article but we have been advised that the change in height of this pulley does not materially affect the mechanics.

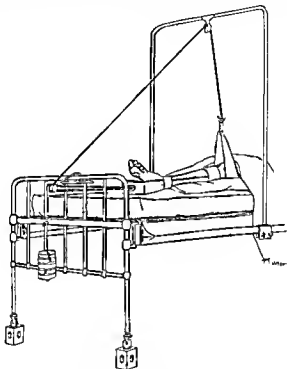


Fig 435

of the extension. The bracket in which this pulley is fixed rides along the frame and may be adjusted in either direction. The frame is held firmly in place by two bolts through a flange over the side bar of the bed. The sling under the knee is made of double thickness muslin and padded with a number of layers of gauze. The position of this sling should be frequently observed and adjusted because of a tendency to move downward.

and produce pressure upon the peroneal nerve in the region of the head of the fibula. We have never seen peroneal palsy occur but a number of patients have complained of pain from this pressure. The cord is carried from this sling to the overhead pulley at an angle of approximately 20 degrees and continues to the foot of the bed over one of the pulleys on the bracket to the pulley on the spreader at the sole of the foot, and finally to the second pulley on the bracket. The adhesive plaster is applied only to the head of the tibia and is held in place by 2 circular bands of adhesive. We usually cover this adhesive with a muslin bandage but intentionally omitted it for convenience. The spreader should be sufficiently wide to prevent pressure upon either malleolus. It will be noted that the pillow under the leg and thigh is soft, and the leg is only slightly elevated. This position results in an approximately parallel pull. In our observation of reports made on this form of extension this position of the leg has been frequently overlooked. The amount of weight represented is 5 pounds which results in a pull of 10 pounds because the lines of force going to the spreader are duplicated. Frequently we have noted reports in which larger amounts of weight have been suggested but bearing in mind that the weight applied is acting through 2 lines of force one hesitates to apply more than 9 pounds in any case. Our rule is 3 pounds for a child to be varied to 9 pounds for an adult. Should too much weight be applied difficulties with the adhesive plaster and the skin will be encountered. Finally the foot of the bed should be elevated to secure proper traction and the patient advised, from day to day, to keep himself up in bed in order to secure the maximum benefit. Usually a few days are sufficient to acquaint the patient with the proper position. Thus movement in bed is not harmful to the fracture, providing the weights are not removed when changing position.

The original pulleys at the foot of the bed, as described by Russell, were attached to an outrigger made of wood. The bracket shown in Fig 436 was first described in the Journal of the American Medical Association but we have been unsuccessful in locating the original.

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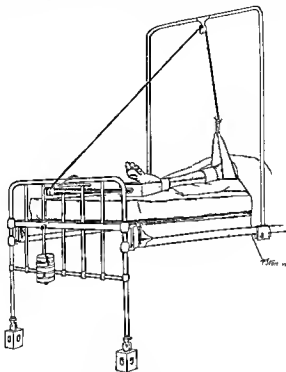


Fig 435

of the extension. The bracket in which this pulley is fixed rides along the frame and may be adjusted in either direction. The frame is held firmly in place by two bolts through a flange over the side bar of the bed. The sling under the knee is made of double thickness muslin and padded with a number of layers of gauze. The position of this sling should be frequently observed and adjusted because of a tendency to move downward

always give the true position of the fracture so that we no longer rely upon the x ray to guide the treatment completely. We now apply a Smith-Petersen nail to fractures of the neck of the femur in good risk patients. The fractures of the base of the neck may be treated with either the Russell extension or a Whitman cast, and good union be anticipated in a large percentage of the cases. The selection of the type of treatment will, as a general rule, depend upon the health of the individual.

2 Intertrochanteric Fracture—This type of fracture is well suited to the Russell form of extension because good reduction is always accomplished and function of the knee and ankle joints is preserved during the course of treatment. We have had excellent results with this fracture and complete union, as a rule, occurs within a period of six weeks. In 2 or 3 instances we have made the mistake of removing the extension too early and bowing at the site of fracture has occurred. We now maintain the extension for at least six weeks and remove it only when x ray examination reveals definite evidence of callus formation.

3 Fractures of the Shaft—We have never encountered any difficulty in reducing the spiral fractures of the shaft of this bone and the end results have been uniformly good. We make it a rule to continue the extension for the full period of healing of the fracture unless, for economic reasons, the patient desires to leave the hospital. We are then forced to apply a plaster cast. The reduction of the transverse fracture has been our greatest problem and should reduction occur we find it difficult to maintain good apposition of the fragments. In the event that complete reduction is not secured within ten days we do not hesitate to perform open reduction, and apply a steel plate. Early in our experience with this extension we attempted to secure union in the transverse fractures without perfect apposition of the fragments, and in a number of instances we discovered that the fragments had become disengaged and mal union was occurring. We do not feel that it is safe to delay operation in the event that perfect anatomic reposition is not secured. In the transverse fracture of the lower third of the shaft we have encountered difficulty in securing reduction of the fracture. This type of fracture very frequently requires wire extension or an open reduction.

the fixed parallel pulleys add to the efficiency of the traction. The bracket is readily applied to any type of bed found in our hospitals.

For convenience and clarity we feel that our experience with this form of traction should be discussed under the following types of fracture:

- 1 Fracture of the neck of the femur
- 2 Intertrochanteric fracture
- 3 Fractures of the shaft
- 4 Intercondylar fracture

1 **Fracture of the Neck of the Femur**—We have made it a rule to classify fractures of the neck of the femur into

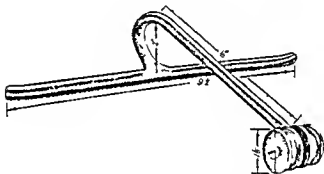


Fig. 436

fracture of the neck and fracture of the base of the neck, rather than intra and extracapsular. For the first five years after we instituted this form of extension we noted in reviewing a group of cases that union was secured in only 25 per cent. The group of cases in which we continued extension throughout the whole course of treatment was composed of elderly patients whom we assumed would not tolerate a Whitman cast

CLINIC OF DR. ADOLPH A. WALKLING

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CONTAMINATED WOUNDS AND COMPOUND FRACTURES

CONTAMINATED WOUNDS

AMONG the important surgical lessons learned during the Great War were certain principles regarding the treatment of compound fractures and contaminated wounds. The war had been going on for many months before the treatment of contaminated wounds as we know it today was consummated. Almost immediately there was a drop in mortality and morbidity. Soldiers that recovered without loss of leg or arm in the latter stages of the war would have had amputation or would have died earlier in the conflict. The same was true regarding compound fractures. Of course the development of gas bacillus antiserum and its routine use since the war has further reduced the morbidity of this peculiar contaminant of certain types of wounds. Early in the war tetanus was quite prevalent but later each wounded man received 1500 units of antitoxin and as a result almost wiped out this disease. If the disease is not prevented altogether by this injection the incubation period is prolonged and the disease is in a much attenuated form.

Gas gangrene caused by a gas producing bacillus and in a vast majority of instances due to the *Bacillus aerogenes capsulatus* of Welch and the *B. oedematiens* or vibriion septique of Pasteur occurred frequently in compound fractures and similar contaminated wounds. Wounds in which there had been destruction of muscle tissue with the entrance of foreign bodies were susceptible to such a degree that limbs were amputated with abandon as a prophylactic against gas gangrene and loss of life. Unfortunately, war wounds were likely to have been received some hours before amputation could be performed.

4 Intercondylar Fracture—We have had only a small number of these fractures and the displacement, as a rule, has been slight. The Russell extension has been used in most instances to preserve knee function. However, ankylosis appears to occur with the same frequency as was encountered with plaster cast treatment.

Five years ago we reviewed 70 cases of fracture of the femur admitted to the Misericordia Hospital. The group consisted of 58 cases of fracture of the shaft, 9 fractures of the neck and 3 intercondylar fractures. The mortality for the whole group was 7 per cent. The extension acted as a satisfactory form of treatment in 80 per cent. Operative reduction was required in 20 per cent. Three cases of nonunion occurred in the fractures of the neck. There were no other cases of nonunion. The average period of total disability for fractures of the shaft in which it was possible to continue the Russell extension throughout the period of healing was five months for adults, and 3.5 months for children. The anatomic result, as outlined by the American Surgical Association, was good in 85.3 per cent, moderate in 14.7 per cent, and bad in none. The functional results were good in 88.8 per cent, moderate in 12.2 per cent, and bad in none. There were no cases in which permanent stiffness in the knee joint occurred.

During the past year we have reviewed our most recent group of 29 cases of fracture of the shaft and find that our operative incidence has now risen to 28 per cent, which figure appears to be approximating the incidence (35 per cent) of open reduction with Buck's extension. All of the open reductions

... are fractures of the shaft. The success of
 convenient, comfortable and inexpensive method of traction in fractures of the femur.

2 Open reduction of the fracture should not be delayed beyond two weeks if the reduction is not considered a good anatomic result.

3 The treatment of a fracture of the femur requires a thorough knowledge of all the factors contributing to a good end result and should be so applied to the individual case.

which was treated with adrenalin and calcium. The patient was discharged on the fifteenth day. The wounds were healed except for the index finger.

Comments—1 It is always necessary to desensitize patients before giving tetanus antitoxin or gas bacillus antiserum. This often saves the patient a severe anaphylactic reaction. Wounds of the hand, especially those due to machinery, seldom need gas bacillus antiserum. They seldom become grossly infected—probably because of the grease.

2 A general anesthetic or a nerve block for hand and arm injuries and spinal anesthesia for leg injuries are methods of choice.

3 I believe flushing a wound with ether to be an excellent procedure. Most antiseptics destroy tissue and thereby add injury to the already damaged tissue cells.

4 Debridement is essential to the proper treatment of any contused and lacerated wound that contains much devitalized tissue. This is the thorough removal by open dissection of all foreign material and of all tissue so devitalized that its recovery is problematical. This painstaking procedure should be done thoroughly with a sharp knife and tissue forceps. The skin edges, devitalized muscle and areolar tissue should be thoroughly and cleanly excised. In this instance the excision of the skin edges and the removal of the areolar tissue and particles of dirt were the most important procedures. The fact that there was no infection gave proof of their efficacy.

5 Flushing with normal salt solution and tight closure is the method of treating open wounds of joints. Drainage should not be used.

6 It should be the policy to save all that is possible, particularly in injuries of the hand and fingers. Ends of fingers are often saved by suturing back in position.

7 A splint is always a great comfort to a patient with injuries of the fingers and hand. The splint should always include the wrist.

COMPOUND FRACTURES

In the treatment of compound fractures one must not only treat the contaminated wound but also treat the fracture. All compound fractures are regarded as emergencies and require immediate and skilful treatment by a skilled surgeon. The size

This fact further increased mortality. Conditions are somewhat different in civil practice. Hospitalization is often merely a matter of minutes and therefore these cases can be treated earlier and with greater success. It is still important that we use all measures at our command in deep punctured or contused wounds and in compound fractures to prevent this complication.

Lacerated and crushed deep or punctured wounds made through a dirty surface or by a soiled agent should be explored, laid widely open, subjected to debridement, mechanical and chemical cleansing and drained or left open (Homans).

The following case will serve to illustrate certain points.

A 19 year old male admitted to Dr. Muller's service March 24, 1937, having had his left hand injured in a punch press at 9:30 A. M. He was brought to the hospital immediately and while in the accident ward was desensitized and given 1500 units of tetanus antitoxin and 1000 units each of perfringens and vibron septique antiserum (comment 1). He had contusion and laceration of second and third fingers, a compound dislocation of the distal phalanx of the middle finger and a compound fracture of the middle phalanx of the index finger. In the operating room under gas-oxygen anesthesia the wounds were thoroughly washed with normal salt solution. Gauze sponges were used (comment 2). The hand was scrubbed with benzine to remove the grease and oil and this was followed by ether (comment 3). Next the crevices of the wound were thoroughly irrigated with normal saline to remove all loose particles of tissue and dirt. Iodine and alcohol were used on the hand after which a debridement was done (comment 4). The tendons were intact. The distal joint of the middle finger was closed without drainage (comment 5). Several sutures were placed in the soft tissue about the fracture of the index finger to hold the fragments in place. The tip of the index finger which was almost severed was sutured loosely back in position and the remaining lacerations were sutured loosely without drainage (comment 6). A splint that included all the fingers and wrist was applied and the whole was placed between warm water bottles (comment 7). The patient had no rise in temperature and when the dressings were changed on the seventh day the end of the index finger was gangrenous. It was removed. On the seventh day he developed urticaria.

covered with sterile dressing. In the case of a large wound, whether foreign bodies have been carried in or not, a thorough debridement is essential. If débridement is done before twelve hours, almost complete closure may be obtained. Beyond twelve hours, wide open packing (Orr method) may be tried. The wound may be left open and sterilized chemically by the Carrel Dakin method. 'Before twelve hours—cleanse and

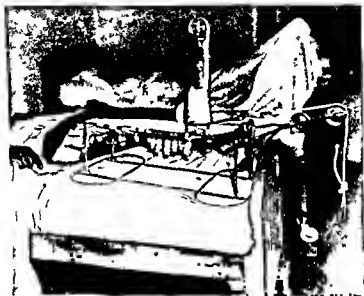


Fig. 437—Braun Boehler splint with Kirschner wire to os calcis for continuous traction

close after twelve hours—cleanse and sterilize" is a fairly good rule to follow.

2 Devitalized muscle has a grayish color, is not stimulated to contraction by pinching and does not bleed. If, after removing all devitalized tissue, the life of the distal member is in jeopardy amputation must be considered.

3 Debridement has distinctly lessened the number of cases of gas gangrene. A thorough removal of devitalized muscle is necessary. Bruised and devitalized tissue hidden from air, particularly muscle tissue with its high glycogen content, forms

of the wound in the skin is no index as to the amount of tissue destruction beneath

Case H G admitted May 20 1937 because of a compound fracture of the right tibia and fibula. He was run down by an automobile and thrown to the street. The fracture was of the middle third and there was a wound about 2 inches long in the skin (comment 1). There were many abrasions on the skin of the leg into which street dirt had been ground. He was given tetanus and gas bacillus antitoxin (combined) 1500 units and 2000 units respectively and taken immediately to

with benzine alcohol and ether. The wound was flushed out with gallons of normal salt solution using an irrigating jar with rubber tubing and glass tip. The wound edges were excised with a sharp scalpel. Foreign bodies and loose pieces of bone were removed. The wound was dried and flushed with ether. Devitalized muscle was excised care being taken to preserve all vessels and nerves possible (comment 2). The wound was thus changed from a potentially infected wound lined with devitalized tissue to a clean wound lined with healthy bacteria resisting tissue. This mechanical cleansing and excising of the wound is the most important step in its treatment (comment 3). The fractured bone ends were approximated and the wound sutured loosely together (comment 4). The leg was placed on a Braun Boehler splint (Fig 437) and a Kirschner wire placed in the os calcis for continuous traction (comment 5). The wound healed without infection. A cast was applied on June 16th after the local skin lesions had healed sufficiently. He was discharged on June 26th with union beginning in the fracture. He was seen in September 1937 and by that time solid union had occurred.

Comments—1 If a splinter of bone has barely broken the skin of the lower leg and retracts beneath the surface it is

CLINIC OF DR EDWARD T CROSSAN

EPISCOPAL HOSPITAL

TREATMENT OF FRACTURES AT THE ANKLE

ACCURATE anatomic alignment of the fragments from the moment of reduction until union has taken place is absolutely necessary in treatment of fractures at the ankle. The method used to secure the excellent anatomic reduction must be buttressed by an immobilization which will maintain the reduction till the end of the healing period. Any variation in the joint line at the time of union even though it be seemingly slight may be the cause for disability and discomfort.

Distortions of the joint lines are at times not recognized on the x ray film but more frequently they are missed by the surgeon during the period of immobilization. In Fig 438 there is shown an x ray film the day after reduction of a bimalleolar fracture. The position has been reported as good yet there is a distinct widening of the inferior tibiofibular articulation and a distinct gap between the internal malleolus and the astragalus. Look at Fig 439 a fracture of the external malleolus reported as in good position and compare it with Fig 440 the x ray of the normal ankle. It is evident that in Figure 439 again there is a distinct widening of the articulation between the tibia and fibula. In the case shown in Figs 438 and 439 was there any attempt made to reduce the deformity and although the end results are not known I feel sure the patients had symptoms for a long period if not permanently. In our End result Clinic I have seen such patients complain of constant pain over the inferior tibiofibular articulation and I have come to feel that these symptoms were due to uncorrected diastasis of the articulation.

The surgeon who places much confidence in simple plaster cast immobilization will have cause for regret. After any fracture reduced immediately and immobilized there occurs within

ideal culture media for organisms of gas gangrene. The bacilli form gas which causes the muscle fibers to separate. The swelling thus produced compresses adjacent vessels causing the destruction of more muscle. The gas spreads rapidly along fascial and muscle planes and nerve sheaths. When gas infection begins, there is usually an abrupt rise in temperature and pulse, marked prostration and sometimes restlessness. There is usually an increase of pain in the wound. Thin dirty fluid with gas bubbles escapes from the wound the edges of which are a grayish brown. A characteristically sickening sweetish odor is present, sometimes termed "mousey" odor. Gentle palpation of the tissues may reveal crepitus although this may not be appreciated in the early stages. Once crepitus appears it may advance appreciably from hour to hour. An x ray may demonstrate gas in the tissues. Immediate operative interference is of the utmost importance once this disease has developed. It may only be necessary to excise the wound and incise the fascial planes. Every particle of diseased muscle tissue must be removed even at the expense of the limb itself. Amputation however, will seldom be necessary if treatment is begun early. Gas gangrene anti-serum should be used in large quantities. Small doses of x ray have been used in the therapy of this condition with a marked degree of success.

4. Plates, screws and such should not be used in the treatment of compound fractures.

5. The bones may be held in place by a plaster cast as in transverse fractures or with continuous traction as in this case. The Braun Boehler splint is an ideal instrument for the treatment of this type of fracture of the leg particularly when continuous traction is advisable. The Kirschner wire has also simplified certain aspects of treatment. Carrel Dakin sterilization of the wound can be carried out on this splint. This type of treatment is not always necessary except in the cases of grossly infected wounds. The contaminated wounds can be excised and closed but the infected wounds must be left open whether they have been excised or not. Once the wound is left open Carrel Dakin sterilization or packing with vaselized gauze should be done.

6. A walking caliper was applied which will be worn for about six months.

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TREATMENT OF FRACTURES AT THE ANKLE

ACCURATE anatomic alignment of the fragments from the moment of reduction until union has taken place is absolutely necessary in treatment of fractures at the ankle. The method used to secure the excellent anatomic reduction must be buttressed by an immobilization which will maintain the reduction till the end of the healing period. Any variation in the joint line at the time of union even though it be seemingly slight may be the cause for disability and discomfort.

Distortions of the joint lines are at times not recognized on the x ray film but more frequently they are missed by the surgeon during the period of immobilization. In Fig 438 there is shown an x ray film the day after reduction of a bimalleolar fracture. The position has been reported as good yet there is a distinct widening of the inferior tibiofibular articulation and a distinct gap between the internal malleolus and the astragalus. Look at Fig 439 a fracture of the external malleolus reported as in good position and compare it with Fig 440 the x ray of the normal alignment at the ankle. Figure 439 again shows a tibiofibular diastasis and a marked gap between the internal malleolus and the astragalus. In neither case shown in Figs 438 and 439 was there any attempt made to reduce the deformity and although the end results are not known I feel sure the patients had symptoms for a long period if not permanently. In our End result Clinic I have seen such patients complain of constant pain over the inferior tibiofibular articulation and I have come to feel that these symptoms were due to uncorrected diastasis of the articulation.

The surgeon who places much confidence in simple plaster cast immobilization will have cause for regret. After any fracture reduced immediately and immobilized there occurs within

the succeeding ten days a subsidence of swelling. Later on, depending on the degree of immobilization, there will be



Fig. 438—Bimalleolar fracture after reduction. Reported by roentgenologist as a good position. Actually there is a separation of tibiofibular joint and a gap between astragalus and internal malleolus.



Fig. 439—Fracture of external malleolus reported as being in good position. Film shows a diastasis of tibiofibular joint and loss of contact between astragalus and both malleoli.

atrophy. The atrophy plus the subsidence of swelling can make the snug plaster cast a loose covering. Unless there be fre

quent x ray examination and a few reapplications of the plaster, the perfectly reduced fracture may be a malunion at the end



Fig. 440—Normal ankle



Fig. 441—Fracture of both malleoli after reduction

of six weeks the deformity can happen even though the plaster is applied to the skin though it is more likely to occur if there be intervening padding Refer to Figs 441, 442

Figure 442, four days after a nearly perfect reduction of a bimalleolar fracture (Fig 441), shows there has been some recurrence of deformity, and also shows that there is an increasing gap between the outline of skin and the plaster



Fig 442—Same case as Fig 441. x Ray taken four days after reduction. Film shows displacement of fracture while the ankle was in a cast



Fig 444—Film taken the day after reduction of fracture at the ankle. Note in the lateral view there is shown an incomplete reduction of posterior dislocation of foot

but any lapse in the treatment of fracture at the ankle is always disastrous. Look at Figs 443, 444. Figure 443 the day after reduction, and Fig 444 eleven weeks later. An inexplicable oversight in the complete reduction of the posterior displacement of the astragalus (shown in Fig 443) has resulted in a painful stiff ankle, as can be deduced from Fig 444.

Weight bearing during the healing period of certain fractures at the ankle is dangerous. This is a reversal of an opinion I held in former years, for I was the author of a paper advocating the Delbet splint for fractures of the leg below the middle third. However, experience has taught me that which



Fig 444—Same case as shown in Fig 443 eleven weeks later. A very poor result.

I should have learned by reasoning. As previously indicated no simple cast, nor any series of casts are of such efficiency that one can be sure of a good result.

on a loose cast must result in displacement in some cases. A study of Figs 445-447 will demonstrate the point. They are pictures of the same patient with a bimalleolar fracture immobilized in a Bohler cast. Figure 447 taken six weeks after reduction and after the same period of weight bearing shows a recurrence of deformity. In this same patient a series of x rays were taken during the immobilization period and a re

Figure 442 four days after a nearly perfect reduction of a bimalleolar fracture (Fig 441), shows there has been some recurrence of deformity and also shows that there is an increasing gap between the outline of skin and the plaster



Fig 442—Same case as Fig 441. X Ray taken four days after reduction. Film shows displacement of fracture while the ankle was in a cast



Fig 443. Film taken the day after reduction of fracture at the ankle. Note in the lateral view there is shown an incomplete reduction of posterior dislocation of foot

Greater care and more vigilance are required in treatment of fractures at the ankle than in the treatment of any other fracture at least that is my belief. Slight errors in reduction may not result in serious disability in other fracture treatments

but any lapse in the treatment of fracture at the ankle is always disastrous. Look at Figs 443-444. Figure 443 the day after reduction and Fig 444 eleven weeks later. An inexplicable oversight in the complete reduction of the posterior displacement of the astragalus (shown in Fig 443) has resulted in a painful stiff ankle as can be deduced from Fig 444.

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Fig. 444—Same case as shown in Fig. 443 eleven weeks later. A very poor result.

I should have learned by reasoning. As previously indicated no simple cast nor any series of casts are of such efficiency that perfect immobilization can be secured for every day of the healing period; that is, the immobilization cannot be maintained by the cast alone. It follows therefore that weight bearing on a loose cast must result in displacement in some cases. A study of Figs 445-447 will demonstrate the point. They are pictures of the same patient with a bimalleolar fracture immobilized in a Bohler cast. Figure 447 taken six weeks after reduction and after the same period of weight bearing shows a recurrence of deformity. In this same patient a series of x rays were taken during the immobilization period and a re-

view of the series disclosed a gradually increasing deformity. Also, x rays were taken with weight borne on the iron and checked against x rays of the same foot without weight bear-



Fig. 445—B malleolar fracture before reduction



Fig. 446 Same case as shown in Fig. 44. Film taken after reduction. Outlines of Bohler iron shown.

ing the test demonstrated an increase of deformity when the patient made pressure against the iron.

In fractures of both malleoli as in Fig. 445 or in fractures of one malleolus associated with a fracture of the shaft of the

companion bone as in Fig 452 weight bearing must be interdicted. If any combination of the above fractures be associated with a fracture of the posterior lip of the tibia this rule should be absolute. In fractures of a single malleolus the Delbet or the Bohler or the Gurd splint has distinct advantages. There is no doubt that with these casts postimmobilization swelling is less and there is no doubt that restoration of joint function is quicker with these methods particularly if weight bearing is permitted by the aid of the Delbet splint.



Fig 447—Same case as shown in Figs 445 and 446. This film taken six weeks after reduction and after same period of weight bearing shows a recurrence of deformity.

In the extensive fractures noted above the bimalleolar the posterior lip fractures etc. I have arrived at the conclusion that cast immobilization even without weight bearing needs an extra guard. In some cases I have incorporated between the skin and cast a heavy piece of sponge rubber. The idea behind the method is that the expansion of the rubber will take up the space between leg and cast which results from atrophy and absorption of bloody exudate. If the fracture fragments have been markedly displaced I am not content with using the sponge rubber guard instead I protect the reduction by a Kirschner wire passed through the os calcis and incorporated in

the cast and on occasions I have used 2 wires incorporated in the cast one through the os calcis and a second one passed through the crest of the tibia about 4 fingerbreadths above the internal malleolus

In all fractures at the ankle cast immobilization secures the best results when the foot is placed in slight varus that is in all cases except the bimalleolar fractures which have resulted from direct violence. In the latter the ligaments are intact whereas in fractures of indirect violence such as twists the ligaments are torn. If the foot be placed in any position other than midposition when the ligaments are intact the altered position will result in deformity.

Reduction of most of the fractures around the ankle is usually not difficult providing an anesthetic either local or general is used. In my experience local anesthesia is less useful in fractures at the ankle than it is in other fractures. On the other hand if a fighting gas anesthesia is given an undisplaced fracture may become a complicated one. The secret in the use of the anesthetic either local or general seems to be the administration of the preoperative sedative at the proper interval that is about one hour before the reduction.

The actual reduction usually can be secured by increasing the deformity as the first maneuver. That is if the foot is in valgus (as it usually is) the foot is pushed laterally and at the same time the fragments are unlocked. Then by traction and countertraction with the knee flexed the foot is brought into alignment with the leg. If in addition the foot is displaced backward forceful forward traction is made on the heel. The last movement is pressure over the external malleolus to force the foot in slight varus except of course in those cases where a bimalleolar fracture has resulted from direct violence. After reduction a cast enclosing sponge rubber over the fracture site is put on extending from 1 inch distal to toenails up to tibial tuberosity with the foot still in varus. If the fracture involves both malleoli a wire is passed through the os calcis and incorporated in the cast. When the cast is hard it is cut on the dorsum to expose the toes but is left long on the plantar surface. As a rule I apply the cast directly to the skin but I take caution to pass a thin strip of zinc over the anterior leg so that the cast can be rapidly split if



Fig 448



Fig 449

Fig 448—Anteroposterior view of fracture unreduced and not immobilized for a period of three weeks after injury

Fig 449—Lateral view of fracture shown in Fig 448



Fig 450



Fig 451

Fig 450—Lateral view of reduction of fracture shown in Figs 448 and 449
Double pin traction used

Fig 451—Anteroposterior view of reduction shown in Fig 450

There are cases where simple maneuvers cannot secure reduction. Figures 448-449 show the x-ray films of a compound fracture that was admitted to my service three weeks after in-

jury. Simple manipulations were unsuccessful. The double pin traction, one pin through tibial tuberosity and the second through os calcis, and traction by the McMullan apparatus,



Fig 452—Before reduction by double pin traction



Fig 453—Reduction of fracture shown in Fig 452

secured the reduction shown in Figs 450, 451. Also in the case shown in Figs 452, 453, the double pin traction was necessary to secure reduction. In the latter case the pins were passed

through os calcis and anterior surface of tibia above the ankle joint. The double pin traction is another gadget, but a very useful one, although even with this immobilization I do not permit weight bearing.

In the cases where there is a tibiofibular diastasis reduction can be secured only by some form of compression traction such as the ice tongs applied to the malleoli or above them, or better still by a compression traction apparatus such as the Knickerbocker tongs. Of course, the use of compression traction precludes the use of cast immobilization.

The position of reduction must be checked and rechecked during the healing period. The position of the astragalus as to the malleoli, the position of the astragalus to the posterior surface of the tibia, and the actual position of the malleoli must be carefully observed. On any change of position of fragments there must be a realignment and new immobilization.

The period of immobilization varies with the type of the fracture. Fracture of a single malleolus need not be immobilized longer than four weeks, certainly not more than six. As a matter of fact some of these fractures have been successfully treated by strapping. In the more extensive fractures, bimalleolar, etc. I have been immobilizing the joint for nine weeks, six weeks, I have found in many cases is too short a period. In the last three weeks of the period weight bearing with a Bohler iron is safe. For the reeducation of the muscles and the reestablishment of joint function, I depend on active motion.

mer

adequately immobilizes the fracture. The reduction, as a rule, is easy but it requires a careful attention to details.

jury Simple manipulations were unsuccessful The double pin traction one pin through tibial tuberosity and the second through os calcis and traction by the McMullan apparatus



Fig 4b —Before reduction by double pin traction



Fig 4c —Reduction of fracture shown in Fig 4a

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EPIPHYSEAL INJURIES IN CHILDHOOD

FROM infancy to adolescence the long bones of the extremities are particularly vulnerable to acute trauma at the points where growth is taking place. This is due to the structural peculiarities about the epiphyseal cartilage, also known as the conjugal cartilage or epiphyseal plate, which lies between the epiphysis and diaphysis at each end of a long bone. Such epiphyseal injuries are usually described as epiphyseal separations with or without displacement and are really fractures wholly or partly through the epiphyseal cartilage. Much less frequently there are seen fractures of the diaphysis which extend through the epiphyseal cartilage and through the epiphysis itself.

In true traumatic epiphyseal separation there is a clear cut history of an adequate external violence to a previously normal structure. This clinical picture should be distinguished from that of pathologic epiphyseal separation in which a slight and ordinarily inadequate trauma causes displacement of an epiphysis because of infectious or dystrophic changes in the epiphyseal area. The difference is analogous to that between ordinary and pathologic fractures. In the class of pathologic separations belong the spontaneous separations, slipping epiphyses and displacements during osteomyelitis and other diseases.

In order to point out the morphologic basis of epiphyseal separation a brief review of the anatomic considerations may be helpful.



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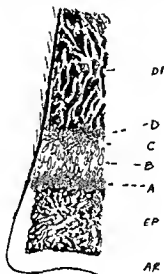
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In order to point out the morphologic basis of epiphyseal separation a brief review of the anatomic considerations may be helpful.

Normal Anatomy—In early infancy a long bone consists of a bony diaphysis with a purely cartilaginous epiphysis at each end. x Ray films of such a bone show the radiopaque diaphysis, but nothing of the entirely radiolucent epiphysis. Sometime during infancy a center of ossification appears in the epiphysis. The ossification of the epiphysis continues until later the whole epiphysis is visible in the x ray films. It re



remains clearly demarcated from the diaphysis by a layer of elastic tissue—the epiphyseal cartilage. Bone growth takes place from the diaphyseal side of this cartilage and while it continues the area remains radiolucent. When growth ceases the cartilage ossifies and the epiphysis fuses with the diaphysis. This time differs for the various epiphyses and to some extent it varies for different persons but in general it is during adolescence.

Diagrammatically the region of growth between epiphysis and diaphysis may be considered as having 4 planes (Fig 454)
 (A) A plate of elastic cartilage which forms new cartilage cells continuously on the side toward the diaphysis (B) These cartilage cells have arranged themselves into longitudinal columns (C) A little further away from the epiphysis the columns of cells show invasion by small blood vessels and beginning cal

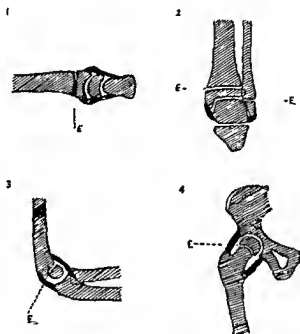


Fig 455—Extra articular epiphyseal cartilages 1 at the lower end of the radius 2 at the ankle Intra articular epiphyseal cartilages 3 at the elbow 4 capital epiphysis of femur E the epiphyseal cartilage

cification (D) In the last area the calcified cartilage is being converted into typical haversian bone

The area C D appears to be most vulnerable to trauma This partly calcified tissue no longer has the elasticity of cartilage, it lacks the strength of true bone, and it is at this level that most separations occur Injury at this level does not affect the growth area A B which is elastic, and which receives

its blood supply from the epiphyseal vessels, unless there is actual crushing of the whole thickness of the cartilage

The relation of the epiphyseal line to the joint space is important because the point of attachment of capsular and other ligaments has a definite bearing on the mechanism of separation (Fig 455)

The epiphyseal cartilage may be extra articular, intra articular or both, in parts The epiphyseal lines at the lower ends of the radius and ulna, at the lower ends of the tibia and fibula, and at the lower end of the femur are wholly extra articular, the capsular and other ligaments having their insertion only on the epiphysis The epiphyses at the elbow and at the upper end of the femur lie entirely within the joints and bear little or no ligamentous attachment At the upper end of the humerus the epiphyseal joint lies partly within, partly without, the joint

The periosteum is densely bound down at the epiphyseal line When the epiphysis separates and moves on the diaphysis the periosteum tends to go with the epiphysis denuding the shaft of part of its periosteal covering The end of the diaphysis may actually protrude through an opening in the periosteal sheath When reduction is attempted the periosteum may then fold in and interpose itself between the fragments If the displacement remains, later bone growth occurs in the periosteal sheath and any protruding portion of the diaphysis is usually absorbed

Mechanism Producing Separation — In the large major

The violence may be spent at this point and such a lesion might be called an incomplete separation or juxta epiphyseal sprain Such a lesion would of course show nothing in the x ray film If the violence is greater, the effect of compression of the opposite side is seen The epiphysis is pushed against the side of

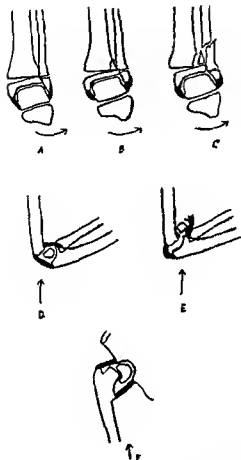


Fig. 456—The result of forcible eversion of the foot is represented *A* When the force is just enough to pull the medial side of the epiphysis away from the diaphysis *B* when the force is enough to cause separation of the epiphysis and diaphyseal fracture without displacement *C* when the maximum force causes epiphyseal separation, diaphyseal fracture and fracture of the shaft of the fibula. Separation of the epiphysis at the lower end of the humerus by a fall on the point of the elbow *D* with slight displacement *E* with the epiphysis dislocated anteriorly through the capsule of the joint *F* the result of upward thrust on the femur—the neck rides upward on the capital epiphysis

the diaphysis, causing a fracture through the lateral margin of the end of the diaphysis. Thus combined epiphyseal separa-

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The epiphysis may actually protrude through an opening in the periosteal sheath. When reduction is attempted the periosteum may then fold in and interpose itself between the fragments. If the displacement remains, later bone growth occurs in the periosteal sheath and any protruding portion of the diaphysis is usually absorbed.

Mechanism Producing Separation—In the large majority of cases the separation is produced by an indirect mechanism.

If the violence is greater, a marked compression of the opposite side is seen. The epiphysis is pushed against the side of

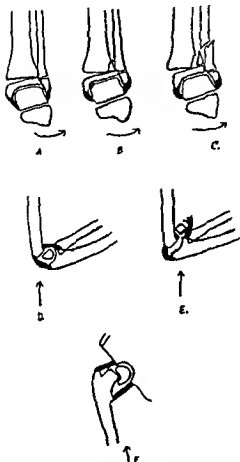


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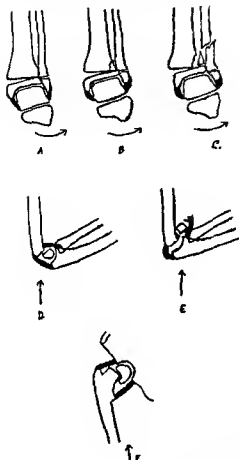


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the diaphysis, causing a fracture through the lateral margin of the end of the diaphysis. This combined epiphyseal separa-

tion-diaphyseal fracture is the common type of injury (Fig 456, *B* and *C*)

Much less commonly separation is caused by axial torsion, by transmitted thrust, by direct violence or by muscle pull. The effect of axial torsion is seen in Fig 458 in which the displacement is essentially an outward rotation of the foot which takes place at the line of the lower tibial epiphysis the articulation between the fibula and the epiphysis moving backward in relation to the tibial diaphysis. Since the epiphyses at the lower end of the humerus and the capital epiphysis of the femur are completely intra articular, ligamentous pull is no factor in displacing them. A thrust on the hand with the forearm flexed makes the coronoid push against the epiphysis and thus tends to displace the epiphysis backward. A fall on the point of the flexed elbow may displace the epiphysis forward (Fig 456, *D* and *E*). So also a fall on the foot with leg and thigh rigid pushes the capital epiphysis of the femur against the rim of the acetabulum and tends to displace the epiphysis downward in relation to the neck of the femur (Fig 456 *F*). The rare separations of the epiphysis at the crest of the ilium and of the epiphysis of the os calcis on which the tendo achillis inserts, are due to violent muscle action.

Frequency and Location of Epiphyseal Injuries—In a series of injuries in the region of joints during the epiphyseal age, Eliason and Ferguson⁴ found that over one third had sustained epiphyseal separations. Compere⁵ found evidence of epiphyseal injury (separation or fracture line crossing epiphysis) in 14 per cent of children who had sustained fractures of the long bones. Epiphyseal injuries are uncommon in infants most common between seven and fifteen years of age.

Types of Epiphyseal Injuries and Associated Bony Damage—Epiphyseal injuries were classified by Bergensfeldt⁶ in two large groups

(*A*) Pure epiphyseal separation in which the fracture line involves only the conjugal cartilage—38 per cent of his cases

(*B*) Mixed epiphyseal separation in which the epiphyseal

	Bergensfeldt ²	Elason and Ferguson ⁴	Compere ³	Ireland ⁶	
Lower radial	137	48	6	6	197
Lower humeral	70	36	11	2	119
Lower tibial	44	4	9	2	59
Lower ulnar	24	9	2		35
Lower fibular	16	2	5		23
Upper radial	8	1	2	3	14
Upper humeral	5	2	1		8
Upper ulnar	2	1			3
Lesser trochanter	2	2			4
Lower femoral	1	3	4	2	10
Upper tibial	1				1
Head of femur		2	2	1	5
Metacarpal				2	2
Phalanx				1	1

(b) Separation with fracture of the epiphysis—6 per cent

(c) Separation with fracture of the epiphysis and diaphysis—4 per cent

(d) Separation with juxta epiphyseal fractures—2 per cent

The Clinical Picture of Epiphyseal Separation—In infants and very young children no history of injury may be elicited. The child may fall from a chair or crib in the absence of the parents, and the incident may not be reported by the servant in charge. The parents may note that the child has suddenly stopped using an arm or leg; that motion of the

... when the separation is complete, visible deformity and mushy crepitus may be

tion-diaphyseal fracture is the common type of injury (Fig 456, *B* and *C*)

Much less commonly separation is caused by axial torsion by transmitted thrust, by direct violence or by muscle pull. The effect of axial torsion is seen in Fig 458 in which the displacement is essentially an outward rotation of the foot which takes place at the line of the lower tibial epiphysis, the articulation between the fibula and the epiphysis moving backward in relation to the tibial diaphysis. Since the epiphyses at the lower end of the humerus, and the capital epiphysis of the femur are completely intra articular, ligamentous pull is no factor in displacing them. A thrust on the hand with the forearm flexed makes the coronoid push against the epiphysis and thus tends to displace the epiphysis backward. A fall on the point of the flexed elbow may displace the epiphysis forward (Fig 456, *D* and *E*). So also a fall on the foot with leg and thigh rigid pushes the capital epiphysis of the femur against the rim of the acetabulum and tends to displace the epiphysis downward in relation to the neck of the femur (Fig 456 *F*). The rare separations of the epiphysis at the crest of the ilium and of the epiphysis of the os calcis on which the tendo achillis inserts, are due to violent muscle action.

Frequency and Location of Epiphyseal Injuries—In a series of injuries in the region of joints during the epiphyseal age, Eliason and Ferguson¹ found that over one third had sustained epiphyseal separations. Compere² found evidence of epiphyseal injury (separation or fracture line crossing epiphysis) in 14 per cent of children who had sustained fractures of the long bones. Epiphyseal injuries are uncommon in infants, most common between seven and fifteen years of age.

Types of Epiphyseal Injuries and Associated Bony Damage—Epiphyseal injuries were classified by Bergenfeldt in two large groups

(*A*) Pure epiphyseal separation in which the fracture line involves only the conjugal cartilage—38 per cent of his cases

(*B*) Mixed epiphyseal separation in which the epiphyseal separation is accompanied by fracture of the diaphysis or epiphysis or both—62 per cent of his cases divided as follows

(*a*) Separation with partial fracture of the diaphysis at one end of the epiphyseal line—50 per cent

	Bergensfeldt ²	Elsson and Ferguson ⁴	Compere ³	Ireland ⁵	
Lower radial	137	48	7	6	197
Lower humeral	70	36	11	2	119
Lower tibial	44	4	9	2	59
Lower ulnar	24	9	2		35
Lower fibular	16	2	5		23
Upper radial	8	1	2	3	14
Upper humeral	5	2	1		8
Upper ulnar	2	1			3
Lesser trochanter	2	2			4
Lower femoral	1	3	4	2	10
Upper tibial	1				1
Head of femur		2	2	1	5
Metacarpal				2	2
Phalanx				1	1

(b) Separation with fracture of the epiphysis—6 per cent

(c) Separation with fracture of the epiphysis and diaphysis—4 per cent

(d) Separation with juxta epiphyseal fractures—2 per cent

The Clinical Picture of Epiphyseal Separation—In infants and very young children no history of injury may be elicited. The child may fall from a chair or crib in the absence of the parents and the incident may not be reported by the servant in charge. The parents may note that the child has suddenly stopped using an arm or leg; that motion of the extremity causes pain or that a swelling has suddenly appeared about one of the joints. Examination usually discloses swelling about a joint, sometimes with ecchymosis. When the separation is complete visible deformity and mushy crepitus may be

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Lesser trochanter	2	2			4
Lower femoral	1	3	4	2	10
Upper t bial	1				1
Head of femur		2	2	1	5
Metacarpal				2	2
Phalanx				1	1

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present, making the diagnosis obvious or the separation may be incomplete and evidenced only by sharply localized tenderness over the conjugal cartilage in addition to the swelling.

In older children the history of trauma is usually clear. Following a blow a jump from a height or a fall while running there is pain well centered about the epiphyseal area. When the separation is incomplete the immediate pain may be so mild as to cause no complaint and swelling and ecchymosis may be so slight as to cause no remark. These children usually come in complaining of persistent soreness close to a joint and sometimes recall the trauma only with difficulty. The clinical diagnosis must rest on the presence of sharply localized wincing tenderness at the epiphyseal line accompanied by swelling and perhaps ecchymosis.

When the separation is complete the local signs are more marked and the characteristic soft mushy crepitus and preternatural mobility may be elicited. In the presence of displacement even though masked by swelling little doubt of the diagnosis can be entertained.

Frequently joint lesions accompany the separation. Moderate effusion may result from trauma to synovium and ligaments. When an intra articular epiphysis separates or when the conjugal cartilage is extra articular and the epiphysis sustains a fracture extending into the joint hemarthrosis is present.

Differential Diagnosis—Clinically epiphyseal separation is differentiated from true fracture by the site of the sharply localized tenderness. In separation it is found at the level of the conjugal cartilage. Dislocation is rare in children except at the elbow. In infants displaced separations at the elbow and knee simulate dislocations closely. Simple strain may give a picture very like that of partial epiphyseal separation but the tenderness is likely to be more diffuse. In any event since the treatment would be the same the difference is not important except for prognosis. The pulled elbow of very young children a condition in which there is pain and disability at the elbow following a twisting pull may simulate an epiphyseal separation. Usually this condition is immediately relieved by manipulation.

x Ray Evidence of Epiphyseal Injury—Before a center

of ossification appears in a given epiphysis the only x ray evidence of epiphyseal separation with displacement may be a change in the alignment of the diaphysis with respect to its neighbor. Frequently, however, a small chip fracture of the diaphysis at the epiphyseal line will give positive evidence of injury.

Even after a center of ossification appears in the epiphysis, if the fracture line runs through the radiolucent epiphyseal line alone, and there is no displacement, films will show nothing. An associated chip fracture of the end of the diaphysis or a fissure in the epiphysis should be sought. Comparison with the opposite normal side may disclose widening or narrowing of the epiphyseal line, or slight lateral displacements.

Although no x ray evidence of epiphyseal separation may be present at the time of injury it may be found later. Bony repair begins at the point of injury and calcification may extend along the elevated periosteum. After a period of three or four weeks calcification may be visible, indicating the site of injury.

Pure epiphyseal separation without displacement gives no x ray signs and therefore it is not excluded when the report of x ray examination is "negative."

Treatment—A child with an epiphyseal separation has a traumatic lesion in which tissue damage, hemorrhage and edema are present accompanied by pain. This lesion is treated like any traumatic lesion. The extremity should be handled gently, and crepitus and preternatural mobility should be sought cautiously, if at all. When the patient is first seen, whether an accurate diagnosis can be made or not effort is directed toward relief of pain, prevention of further damage and dispersal of swelling by immobilization, compression, elevation, the application of cold and the administration of a sedative if necessary.

The part is accurately and snugly splinted. For shoulder injuries the axillary pad sling and swath dressing serves well. For elbow immobilization the internal right angle splint, for the wrist the dorsal wood splint, for the knee the posterior wood splint and for the ankle a long wood splint are easy to use, practically always available, and cast no confusing shadows in the x ray film. A firm flannel or elastic bandage is applied

over the splint and the part is put at rest by the use of a sling for the arm or crutches when a leg is involved. A sedative should be given if the pain is not relieved by immobilization. The patient is instructed to keep the part elevated and at rest and to apply an ice bag during the first twenty four or forty eight hours after injury.

Once the part has been immobilized the patient is sent for x ray examination. Good anteroposterior and lateral views must be obtained and occasionally the opposite side must be examined for comparison. The cases now fall into two groups.

(A) When displacement is trifling or absent the dressing is not disturbed and the program outlined above is continued. After three to five days the swelling usually subsides sufficiently to permit the application of a cast in wrist, elbow and ankle injuries. The unpadded plaster cast for wrist and elbow injuries and the unpadded cast and walking iron for ankle and foot injuries give very accurate and undisturbed immobilization, cannot be loosened by a child, allow active use of the extremity and necessitate the minimum of after care and physiotherapy.

Immobilization is maintained over a period of three or four

used afterward

(B) When displacement of the epiphysis is present reduction should be carried out without undue delay. This should not be taken to mean that a manipulation must be done on the spot. As a general rule the best plan to follow is this:

- 1 Immobilize
- 2 x Ray get good clear films
- 3 Arrange for suitable anesthesia, assistance and plaster
- 4 Have the films in sight during manipulation
- 5 When reduced apply molded plaster splints or other suitable splints
- 6 Then continue treatment as in group A—to disperse swelling—and apply an unpadded cast where indicated

DISPLACEMENTS AND THEIR CORRECTION

At the Wrist —Lower End of the Radius (Fig 464) — The epiphysis for the lower end of the radius is more commonly separated than any other. A fall on the outstretched hand is the usual cause. The epiphysis moves toward the dorsum and to the radial side and the resulting deformity is very like that in Colles' fracture. Reduction usually is not difficult and is carried out by making traction on the hand in palmar flexion while pressure is made on the dorsum of the wrist at the point where the displaced epiphysis bulges. Comparison with the opposite wrist or fluoroscopic inspection discloses any residual deformity. With the hand in palmar flexion and ulnar deviation, anterior and posterior molded plaster splints are applied from the elbow to the knuckles and bandaged securely.

Residual displacement need cause no great concern. It has been demonstrated that healing occurs in such a fashion that displacements disappear within a year (Aitken¹ Eliason and Ferguson⁴). Repeated manipulations or osteotomy are inadvisable.

Lower End of the Ulna —Separation of the lower ulnar epiphysis rarely occurs as an isolated injury. It is usually a complication of suprazyloidal fracture of the radius (Colles') or separation of the lower radial epiphysis. It is reduced by traction and direct pressure when the radial fragment has been replaced.

At the Elbow —Lower End of the Humerus —In the cartilaginous epiphysis of the lower end of the humerus a center of ossification appears at the second year. It lies in the capitulum and its appearance is followed by that of centers in the trochlea and internal epicondyle at the eighth to eleventh year. During the thirteenth year these centers unite, and they fuse with the shaft about the seventeenth year. Up to the ninth year the capitellar portion of the epiphysis lies anterior to the midline of the humerus, as seen in lateral x ray views. The epiphysis for the internal epicondyle does not join the shaft until the eighteenth year.

Clinically (Howard⁵), in the first decade of life, either the whole epiphysis separates, or the capitellar portion alone. The violence is usually direct—a fall on the flexed elbow, and when the force is great enough the fragment may be dislocated and

forced upward anteriorly through the anterior portion of the joint capsule (Fig 456, *D* and *E*) In these cases, when closed reduction fails open operation is warranted

In adolescence, the epiphysis for the medial condyle the last to fuse, is not infrequently separated The force is that which causes lateral dislocation Displacement of the fragment into the joint may necessitate open operation

When the epiphysis as a mass is displaced backward on the shaft the condition is mechanically similar to that in the extension type of supracondylar fracture and can be similarly treated by manipulation and splinting at a right angle or in acute flexion

Upper End of the Radius—The upper radial epiphysis may be separated by the trauma that causes dislocation at the elbow It is rare as an isolated injury The head of the radius is held in contact with the ulna and the capitellum by the orbicular ligament If the fragment slips out from under the ligament open operation is necessary If it has not slipped out it may be molded into place After manipulation or after operation reduction may be maintained by dressing the elbow in acute flexion or by the use of an unpadded cast from the axillary fold to the knuckles in the right angle position

Olecranon Epiphysis—Separation of the olecranon epiphysis is rare In one case the epiphysis was fractured by a fall on the point of the elbow (Eliason and Ferguson⁴) There was no displacement and satisfactory recovery followed immobilization on an internal right angle splint

At the Shoulder—Upper End of the Humerus—The upper humeral epiphysis is formed by the fusion of three centers of ossification about the sixth year It is cup shaped and it rests on the convex upper end of the diaphysis Separation of this epiphysis occurs in the adolescent years The injury is similar to fracture at the surgical neck in that the short rotators of the shoulder are attached to the epiphysis and bring it

reduced the tendency to displace is slight and immobilization by axillary pad sling and swath is sufficient Where reduc

tion is difficult or dangerous (axillary vessels) continuous traction may be employed

At the Ankle—Lower Epiphysis of the Tibia (Fig 456, A, B and C) —The lower tibial epiphysis is usually separated by forcible torsion or eversion of the foot and the separation is almost always associated with fracture of the end of the diaphysis. Displacement can be corrected by retracing the direction of the displacement. Considerable force may be necessary. Moderate overcorrection should be used to maintain the position.

As in separation of the lower radial epiphysis, residual displacement after reduction is overcome by bone growth in a few months. Repeated manipulation or osteotomy is therefore inadvisable. Late deformity follows crushing of the growth area and is not a sequel of malposition of the epiphysis *per se*.

Lower Epiphysis of the Fibula —This separation is rare. Displacement is corrected by the same method used for the lower tibial epiphysis.

At the Knee—Lower Epiphysis of the Femur —Lower femoral epiphyseal separation is usually the result of abrupt and forcible overextension at the knee. The epiphysis is displaced anteriorly carrying with it the knee and leg as a unit. The end of the diaphysis moves downward and backward into the popliteal space where it may compress or sever the popliteal vessels and nerves. Reduction is performed by extending the knee and making traction upward on the thigh and downward on the leg while the knee is flexed. Due consideration must be given to the popliteal structures. The reduction may be readily maintained by dressing the knee in flexion with plaster splints or adhesive.

At the Hip—Capital Epiphysis of the Femur (Fig 456, F) —Separation of the capital epiphysis of the femur by a single acute trauma is rare. When displacement occurs, the neck of the femur rides upward along the epiphyseal line. The Whitman method of reduction usually succeeds and a plaster cast in extreme abduction maintains position well.

These cases are frequently seen late and may require open operation.

RARE EPIPHYSEAL INJURIES

The epiphyses for the metacarpals metatarsals and phalanges may be fractured or displaced (Fig 466) They are treated like the equivalent fractures in the adult

Separation of the epiphysis for the crest of the ilium for the lesser trochanter of the femur and for the posterior portion of the os calcis are caused by violent muscle pull Slight displacements require only immobilization Marked displacement may require open operation

The lip of the upper tibial epiphysis which forms the tibial tubercle may be fractured by direct violence Displacement is negligible and only simple immobilization is necessary

COMPOUND EPIPHYSEAL SEPARATIONS

Compound epiphyseal separations like compound fractures are surgical emergencies Debridement is the treatment of choice if the patient can be brought to an operating room within six or eight hours and the steps of the operation are

- 1 Cover the wound and cleanse the skin
- 2 Trim crushed skin edges
- 3 Remove all dead or crushed soft tissue
- 4 Accurate hemostasis
- 5 Replace fragments
- 6 No internal fixation or deep sutures if possible
- 7 Close skin loosely
- 8 Immobilize in plaster

After operation the extremity is kept elevated and a policy of noninterference is followed

INDICATIONS FOR OPEN OPERATION

Failure to reduce a separation by closed methods is an indication for open operation when displacement is great when soft parts are interposed between the fragments or when displacement is maintained by muscle pull However moderate displacements at the lower end of the radius and at the lower end of the tibia are usually overcome in the course of repair

the main vessels In the presence of great swelling or when the fragments are sharp closed methods have a considerable

element of danger and should be used with extreme caution. If, under these circumstances, reduction cannot safely be effected, open operation is warranted. The absence of a pulse distal to a separation is an urgent indication for operation.

In these operations internal fixation is to be avoided if at all possible.

EFFECT OF EPIPHYSEAL INJURY ON BONE GROWTH

Epiphyseal injury frequently results in some disturbance of bone growth as seen in later *x* ray films (18 of 19 cases—Compere³) but much less commonly is there arrest of growth sufficient to cause any visible deformity (5 per cent of cases—Bergensfeldt²).

Failure to reduce displacement is not a cause of growth arrest. In many cases in which reduction is incomplete later active bone growth pushes the diaphyseal site of separation further and further away from the epiphysis, while some cases without any displacement whatever later show failure of osteogenesis.

The structure of the epiphyseal cartilage explains this to some extent. Ordinary separation may be represented as an injury in which the epiphysis is torn away from the diaphysis at the level of calcifying cartilage with little or no damage of the actively proliferating cells of the elastic layer below. When the epiphysis is crushed or impacted against the diaphysis the whole thickness of the conjugal plate between the two may be damaged, the actively proliferating side of the cartilage suffering as much as the calcifying side. Microscopically cases of growth arrest are said to show diminution of the number of actively proliferating cartilage cells in the epiphyseal side of the cartilage and failure of these cells to arrange themselves in characteristic rows.

Clinically, there seem to be no signs by which the damage to the epiphyseal cartilage itself can be determined, just as there are no signs by which the prognosis for growth can be judged. This is of importance particularly at the wrist and ankle when one of the two epiphyses separates while the other is uninjured. Failure of growth in one with normal growth in the other, may result in marked deformity.

Rarely, an increase in length may follow epiphyseal injury

TYPICAL CASES OF EPIPHYSEAL INJURY

Case I—J R, a boy twelve years of age About 11 A M May 15, 1937, he made a running jump and twisted his right leg He was brought to the Mt Sinai Hospital shortly after ward Physical examination showed swelling at the ankle The foot was rotated outward about 30 degrees on the leg (Fig 457) and there was marked tenderness at the lower tibial epiphysis and over the lower end of the fibula There was a prominence present at the lower end of the tibia The antero-posterior diameter of the ankle was about 1.5 cm greater than



Fig 457—Case I Shows the outward rotation of the right foot

on the left The films (Fig 458) show a separation of the lower tibial epiphysis The epiphysis has rotated outward on the axis of the diaphysis carrying the inferior tibiofibular articulation backward There is an oblique greenstick fracture of the fibula above the articulation

At 4 P M on the same day he was given nitrous oxide anesthesia The leg was grasped in one hand and the forefoot in the other and by forcible inward rotation and forward pull on the foot the deformity was readily overcome A slushy crepitus was palpable as the fragments moved and a distinct



Fig 458—Case I The films show an unusual type of separation of the lower tibial epiphysis. The displacement is essentially external rotation of the epiphysis with the ankle and foot as a unit, on the longitudinal axis of tibia.



Fig 459—Case I Anteroposterior view after reduction. The fracture of the tibial diaphysis is visible as a fissure. Fracture of the fibula can be seen.



Fig 460—Case I Lateral view after reduction The tibial and fibular fractures are not visible



Fig 461—Case I Views of the unpadded cast applied after removal of the molded plaster splints Note the molding below the knee and at the ankle

snap was felt as the maneuver was completed. Reduction was complete (Figs 459, 460). Two lateral molded plaster splints were applied, covered by an elastic bandage. The leg was kept elevated and ice bags were applied to the ankle.

On May 20, 1937, five days after the injury, an unpadded cast was applied from the toes to the knee and a walking iron was incorporated (Fig 461). On the following day he was discharged from the hospital with instructions to use the leg actively. He was last seen on June 9, 1937, walking well in his cast, without pain.

Case II—C. H., girl, twelve years of age. On August 26, 1936, she fell while on roller skates and injured her right ankle.

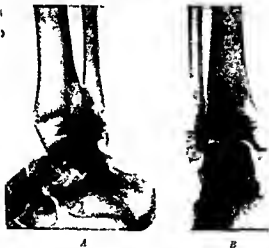


Fig 462—Case II. The lateral view of the ankle shows the directly posterior displacement of the lower tibial epiphysis with a fragment of diaphysis attached while the anteroposterior view looks normal.

She was brought to University Hospital, where x ray examination disclosed separation of the lower tibial epiphysis, which was displaced backward, carrying with it a large fragment of diaphysis (Fig 462). The displacement was reduced and lateral molded plaster splints were applied, covered by a snug bandage. On September 2, 1936, an unpadded cast and walk-

ing iron were applied from toes to knee and active use was advised. In the cast she walked well and was able to climb stairs without difficulty. On October 23, 1936, the cast was removed and an elastoplast bandage wrapped on from toes to knee. This was later replaced by a gelatin boot. No physiotherapy was used. On December 9, 1936, she had no swelling, had full motion at both ankle and knee and could walk and



Fig. 463—Case II. These films taken two months after injury show excellent reduction. The lateral view shows the callus formation mainly along the posterior surface of the tibia.

run without discomfort. x Ray showed good union (Fig. 463) and she was discharged. Her mother reported on May 31, 1937, that she had no complaints whatever.

Case III—J. N., boy eight years of age. On October 3, 1935, he took a dive down 5 steps and landed on his hands and his face. He complained of pain in both wrists and in the nose. He was brought to University Hospital on the following day. x Ray examination showed a fracture of the nasal bone in good position, an impacted epiphyseal separation of the left radius with dorsal displacement of the epiphysis and a fracture of the dorsum of the diaphysis and a fracture of

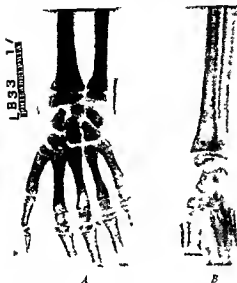


Fig 464—Case III Separation of the lower radial epiphysis The epiphysis has been displaced dorsally and toward the radial side and impacted on the diaphysis

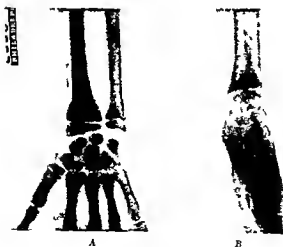


Fig 465—Case III These films were taken five weeks after injury Callus formation is clearly visible in the anteroposterior view

the lower end of the left ulna (Fig 464), and a molecular supra styloid fracture of the right radius in good position. The displacement of the fragments on the left side was insufficient to warrant reduction and molded plaster splints were applied to both forearms. These splints were periodically removed and the arms massaged a scheme of treatment which has now been abandoned in favor of the unpadded cast with active use.

On October 23, 1935, the splints were discarded and cautious active use was allowed. On November 9, 1935, the right wrist was in excellent condition and the left showed moderate thickening with slight limitation of pronation supination and flexion. He was discharged. x Ray showed callus formation (Fig 465).

Because of the impaction of the left lower radial epiphysis on the diaphysis, a crushing injury of the epiphysis must be suspected. Therefore the prognosis as to interference with growth must be more than ordinarily cautious.

Case IV—T B boy, nine years of age. On January 28 1937, a boy stepped on the tip of his left third finger. The



Fig 466—Case IV. The lateral view shows separation of the epiphysis of the terminal phalanx. There is also a chip fracture of the diaphysis.

nail was torn from its bed and the finger bled freely. He was brought to University Hospital on the following day. x Ray

examination disclosed an epiphyseal separation of the distal phalanx with a fracture of the diaphysis, the diaphysis being



Fig 465—Case IV These films show almost complete reduction

angulated toward the palmar side (Fig 466) A hairpin splint was applied and it was covered with elastoplast bandage On



Fig 466 Case IV Three weeks after injury Good position callus almost movable

February 1 1937 the swelling had subsided sufficiently to allow manipulation Under block anesthesia at the base of the finger

the diaphysis was pushed hard toward the dorsum, reducing the displacement, and a thumb shaped plaster cast was applied to the web of the finger. While soft, the plaster was molded at the fingertip to maintain reduction. The film after reduction (Fig 467) shows the position and the dressing. On February 20, 1937, the cast was removed. x Ray showed good position of the fragments (Fig 468). The wounds had healed well in the cast.

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CLINIC OF DR TEMPLE FAY

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THE TREATMENT OF CEREBRAL TRAUMA BASED UPON THE LAWS OF CEREBRAL HYDRODYNAMICS

IN the brief time available for this presentation only the most obvious considerations regarding the modern treatment of head injuries can be discussed

The former 'do nothing' policy and the fatalistic attitude which the profession has assumed regarding injuries to the brain and nervous system are no longer tenable

Up until 1921 fracture of the skull with severe injury to the nervous system was fatal in from 30 to 40 per cent of patients A survey of the methods of treatment in vogue prior to this period indicates that an average mortality of around 28 per cent was prevalent in the best equipped and managed hospitals and institutions throughout the country

As late as 1929 the mortality as reported by Wortis and Kennedy in 1000 cases treated in Bellevue Hospital New York, proved to be 37.8 per cent whereas the survey of Mock, Morrow and Shannon (1934) comprising 3278 cases collected from private patients and the large hospital services throughout the country showed a mortality ranging between 26 and 40.6 per cent Their mortality figures representing a wide cross section of the country correspond closely to those existing twenty or more years ago

In contrast to these figures a convincing number of cases (over 1000) have been treated with consideration of the problems of cerebral hydrodynamics consisting of repeated spinal fluid drainage dehydrating measures and restriction of fluid intake The mortality in this series has remained consistently below 20 per cent

In my own series of cases analyzed over a period of fifteen years and now totalling more than 700 in all an average mortality of 14.5 per cent was obtained by methods of treatment known as dehydration. During the last two years the mortality in my own series as well as that of Drs. Mock, Jenkins, Delaney and others ranged between 9 and 11.5 per cent.

It is obvious that the profession is met with a definite challenge to justify the current discrepancy between a carefully planned and regulated method of treatment which yields a mortality around 11 per cent and the existence of a 26 per cent average mortality throughout the country, based upon the hospital records of Mock's survey in 1934.

A difference of 5 or 10 per cent in the mortality might arise between certain methods due to various factors, but a difference of from 15 to 30 per cent in the mortality during the treatment of any condition in medicine requires a definite explanation. It is high time that the medical profession began to take cognizance of the fact that at least 25 human lives out of every 100 will be sacrificed because of an inadequate understanding regarding the treatment of this ever increasing problem.

With the advent of the machine age and rapidly moving forces combined with the fact that man has surrounded himself by hard and unyielding materials in his modern civilization the number of cerebral injuries increases daily and the totals for our nation become appalling.

Swift reports approximately 112,000 cases of fracture of the skull annually in the United States alone. Major G. F. Lull of the United States Army finds that trauma received in automobile and motor-cycle accidents leads all others as a cause of death in the army. The National Survey Council reports in 1932 that 33,000 individuals met violent death by motor vehicle alone. The War Department records show that the U. S. Expeditionary Force in the World War lost 50,385 killed in action or died of wound during the entire war.

The Surgeon General's office indicates that in 1929 103,942 individuals died in the U. S. from violent causes. If this represents only 25 per cent of those who received injuries but recovered it suggests the staggering figure of almost 400,000 individuals in this country alone subjected to severe injuries which require careful treatment. If only 10 per cent of this

group could be saved by any demonstrable method of treatment it would amount to approximately 10 000 lives annually. If such a reduction in mortality were possible in cancer or malignancy the medical profession and the world would acclaim the method of treatment that could yield such results. However cerebral trauma has been surrounded so long with the "mystery of the brain" and the false and fatalistic attitude that such cases are usually hopeless that the profession and the public accept this relentless annihilation of a large percentage of the population without efforts to establish logical and comprehensive methods of correction.

THE BASIS OF THE MODERN TREATMENT KNOWN AS DEHYDRATION

Let us turn for a moment to the basis and origin of modern methods of treatment responsible for this impressive reduction of mortality in head trauma.

Scientific research contributed an outstanding observation in 1919 which has changed the methods of treatment which had formerly been applied to problems concerning injury or pressure to the brain.

Dr. Lewis Weed observed that a fall in cerebrospinal fluid pressure could be obtained by the administration of hypertonic solutions into the gastrointestinal tract or into the veins of animals. This simple and now obvious finding has led to a vast amount of clinical and scientific research which has clarified many of the old problems surrounding the function of the brain.

In 1921, the author found that the familiar and obvious rise and fall in the fontanels of infants could be influenced by the forcing of fluids on the one hand or the giving of magnesium sulfate (Epsom salt) by mouth or bowel on the other. The tides of fluid within the skull responsible for the rise and fall of the fontanel were controllable depending upon the amount of fluid administered to the infant. Methods of dehydration similar to those which had been demonstrated in the animal by Dr. Weed were adopted to suit the needs of pathologic states.

As the skull of the adult is unable to expand or contract it is obvious that injuries producing swelling of the brain tissue

were promptly followed by the equivalent loss of some other volume component of the cavity. If the blood volume component was reduced to make room for the swelling or edema anemia followed and with the lack of oxygen available, function of the brain began to fail or in other words progressive symptoms arose in proportion to the degree of local or general anemia. Consequently, the clinical measures designed to subtract the excess of fluid so as to permit a return of blood to the brain were adopted in September, 1921, and applied to patients suffering from fracture of the skull and injuries to the brain, as well as to certain cases of brain tumor. The beneficial results of this program were noted and reported in 1922. As these dehydrating measures led to the dramatic saving of several lives in cases which formerly were considered hopeless, the method was gradually elaborated and now forms the basis of treatment for many conditions which demand an improvement in cerebral circulation and the correction of certain symptoms.

From 1921 to 1924, a method of treatment was evolved and devised which combined not only the direct drainage of spinal fluid by lumbar puncture but liquids were carefully restricted during the first ten days following the injury, in order to limit edema and obtain the advantages of better circulation to the brain during the reparative period.

In 1924 Howe observed that hypertonic glucose solution administered intravenously favored in the experimental animal an absorption of fluid and edema from brain tissue.

Dr. Max Peet and I decided at that time to undertake direct

— — — — — where edema of the brain

Dr. Peet reported his find

per cent glucose solution,

the author was unable to obtain satisfactory 25 per cent sterile solutions of glucose at that time and therefore chose the sterile 50 per cent glucose solution then available in ampules for the treatment of diabetic coma. 25 to 50 cc. of the solution was used intravenously.

The beneficial symptomatic results were at once obvious and in those cases where its use was distinctly indicated 50 per cent glucose solution became a necessary adjunct to the treatment of severe cerebral trauma associated with shock.

During 1925 and 1926 it became evident at the University of Pennsylvania Hospital, where the author's observations were then being carried on that the use of glucose solution not only favored dehydration of the brain but was a prompt and efficient means of combating surgical shock. Its use for this purpose was immediately adopted by the surgical section of the University Hospital Dr I S Ravdin being one of the first to recognize its importance. Its use and application rapidly spread far in advance of any published results and where twelve years ago it was practically unknown as a therapeutic agent today it takes its place as one of the major items in the hospital or clinic armamentarium for the treatment of shock and in certain instances the control of increased intracranial pressure.

The widespread and popular use of 50 per cent glucose solution far exceeded its justification in many cases and even today its secondary and harmful reactions are scarcely recognized by those who seized upon it as a panacea of treatment.

During the past ten years it has been more and more obvious that hypertonic glucose properly used as a dehydrating agent is one of the most valuable measures that a clinician may employ under certain circumstances but that glucose has the property of promoting a secondary phase of cerebral edema if certain conditions are not carefully borne in mind and the properties of hypertonic glucose itself not thoroughly understood.

In summary therefore we may say that the experimental evidence offered by Weed showed that it was possible to reduce

trauma. A logical sequence was the reduction of fluid intake by the patient as a means of controlling production of cerebrospinal fluid. Eventually the use of intravenous hypertonic glucose solution was found to aid in this process. The evolution of the method of treatment popularly known as dehydrating therefore concerned itself with the control of fluid balance in the body and the constant regard and care for its accumulation and production within the skull. Frequent spinal drainage as a method of direct and prompt relief became inter

woven with these other measures to bring forth the present method of treatment

CERTAIN COMMON SENSE CONSIDERATIONS REGARDING THE REPAIR AND FUNCTION OF INJURED TISSUE

It is obvious that whether we have an open wound of the body or a bed sore, we desire to obtain healing processes that will repair the injury or damage to the tissue, no matter how produced. To obtain healing and repair there must be adequate circulating blood oxygen nutrition and reconstructive processes which nature has universally employed, whether in the brain or in the less important tissues of the body.

In the case of a wound or chronic ulcer, the surgeon favors the *maximum* of blood supply to assist him in the healing process. In the vast majority of tissues of the body, expansion and swelling are possible, permitting an increase in the blood supply to the area involved. This is not true in the case of the long bones and the cranial cavity. It is impossible for the skull to expand in order to accommodate the needs for extra

robs it

sore to

appropriate amount of blood for reparative processes? Yet, many so called 'surgeons' today permit a brain to become involved in a relentless hydraulic compression squeezing the blood out of this vital and important tissue so that it becomes a gray white anemic mass. In the presence of damaged and swollen tissues, confined within the unyielding cast of the skull, Nature struggles on without an opportunity to obtain the necessary blood to maintain that portion of tissue which remains intact, much less promote the favorable hyperemia so necessary for immediate and speedy repair to the actually damaged portion.

The treatment of a wound or bed sore is simple. Circulation may be encouraged by heat, massage, proper relief of pressure and local factors concerned with dressings, treatments and the constant favoring of hyperemia. The brain is not only inaccessible for these measures but the tissue itself could not survive such manipulation.

If we are to admit that the basic surgical principle concerns the favoring of adequate circulation to the injured area and part, then we must apply this basic surgical principle to the considerations surrounding injured tissue of the brain.

The problem is obviously to deliver sufficient blood supply to the damaged brain and be sure that there will not only exist sufficient space for the general needs but that delivery of blood through the mechanism of blood pressure and blood volume will continue to be adequate.

As the skull contains 3 distinct mass components we must analyze the problem as to which one of these components is the least necessary and can be physically altered during a period when more volume will be required within the closed space by the important structures themselves.

VOLUME COMPONENTS WITHIN THE SKULL

1. Blood within the arteriovenous tubes fills a variable space depending upon whether hyperemia or ischemia of the brain is present.

2. The skull cavity contains cells, the majority of which deal with the function of the nervous system, many however take up their duties comprising the walls of blood vessels, the meninges and dura. This volume may vary greatly with edema, clot or swelling.

3. The third volume consists of free cerebrospinal and ventricular fluid (representing fluid lying outside of the cell walls) together with a large amount of interstitial fluid actually outside of the cells as well as the vascular tubes. This extracellular or interstitial fluid comprises a substantial volume of the brain cavity, the cerebrospinal fluid portion of which amounts to approximately 120 cc (4 ounces in the adult).

The problem when given an injury to the brain with consequent swelling of tissue in response to injury (similar to other tissues) is then to compensate for this change in brain volume.

and at the same time to maintain an adequate volume of circulating blood in the presence of a diminishing space relationship

It is obvious that we do not wish to further destroy brain tissue or remove brain volume if the patient is to recover with his faculties intact. If we open the skull to make more room for the swollen brain (decompression) we shall find that we have herniation of the tissue and further trauma to the part. Decompression enlarges the container in order to permit a necessary return of blood to the brain. The relief of pressure afforded is only another way of saying we are attempting to meet the demands of Nature which required increased pressure to push blood into the needed area. Stop the heart and you will find the pressure immediately disappears. In the terminal stages of the majority of such cases the clinician will find that intracranial pressure as measured by lumbar puncture is actually low. The period of *compensation* has passed and circulation to the brain has eventually failed. In the past these low or normal pressure readings have only served to bewilder the clinician who has been taught to consider pressure as an index of cerebral function rather than *volume* of blood and oxygen actually available to the part. It is true that certain pressure values accompany normal volume relationships but the tissue depends upon oxygen availability for function irrespective of the pressure. Thus we find patients with high pressures (notably in brain tumor cases) with few actual symptoms referable to the function of the brain. In spite of the pressure circulation of blood remains adequate. On the other hand the misleading paradox is frequently encountered where pressure is low or normal and the patient is actually unconscious (widespread loss of brain function)

we do not wish to alter unfavorably the amount of blood circulating within the vascular tubes of the cranial cavity as this is our most important ally in the processes required for maintenance and repair. In fact our attention and treatment must be concerned with actually favoring a temporary *increase* in

the blood volume component within the skull for reparative purposes. This presents the dual problem of compensating for brain volume increase and creating the needed space for blood volume as well.

It is obvious that the third volume component (cerebrospinal fluid) is alone available for manipulation and as it is relatively unnecessary for repair and survival of the tissue it may serve as a means of successful adjustment in the relationships of the other two. Hence it becomes the logical factor to deal with by any or all methods designed to promote favorable space adjustments within the cranial cavity.

All of these considerations would probably be unnecessary if the skull were elastic or the brain could find an easy method

ing walls such as the skull?

As we have a simple physical hydraulic mechanism the laws of physics and hydraulics apply here as elsewhere.

"Liquids are incompressible" The total volume of the container is fixed hence as one volume increases there must be an immediate and reciprocal decrease in the other volume components to adjust this physical mechanism or the container itself must be enlarged.

Decompression as a surgical procedure became the method of the old school because it permitted the container to be enlarged beyond the normal skull confines. Usually the operator intended to close the scalp or temporal muscle frequently the operator found the brain contents expanded beyond the limits provided by his opening as more volume was required than could be surgically provided. Herniation of the brain tissue ensued with exposure of the cortex to damage or infection.

Herniation of the brain not only injures and destroys innocent tissue but the surgeon himself, no matter how skilled is not able to perform this operation in the presence of a brain under pressure without producing marked changes in the area exposed and needless to say much unnecessary trauma. The mortality record of this group of emergency decompressions without regard for the physics and hydraulics of the problem is written as one of the black pages in medical history.

Too frequently in the past, the surgeon satisfied himself with the dictum that "it is a fracture of the skull and the patient will probably die anyway" and without attempting to adjust the mechanism, assumed the role of a final judge proceeded to immediate operation when other measures of a more conservative nature would not only have increased the chances for success of the operation but in themselves might have avoided the necessity of such an operation.

In summary and without going into the reasons beyond the obvious I may say from my own experience and the experience of others, since I have taken up the crusade against promiscuous decompression in cases of cerebral trauma during the past twelve years the facts indicate that a decompression of the brain is justified *only* as a measure of last resort and when all other methods have failed. There is approximately an 8 per cent chance that such an operation may turn the tide in favor of the patient. This is not to be confused with the logical and considered exploration for hemorrhage, clot, epidural hemorrhage, subdural hemorrhage or even a large focal, intramedullary hemorrhage which must follow the rules and criteria concerning brain tumors as these blood clots represent acute tumor masses and should be dealt with from the standpoint of removal of an undesirable volume. Exploration however is not to be confused with the method of subtemporal decompression or the opening of the cranial cavity for relief of intracranial pressure, alone.

In the author's series of over 700 cases 17 patients have

but that where every means of relief had been afforded the patient in only about 3 instances out of every 100 cases is decompression justifiable. The operative mortality then ranges around 92 per cent. One of the reasons for our low mortality throughout this large series is due to the fact that we abandoned surgical decompression as a routine procedure more than twelve years ago.

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sion does not yield more than 2 to 3 ounces of additional space when the skull is opened and the brain is permitted to bulge beneath the temporal muscle. Hence spinal drainage will offer as much space as the average decompression. Subtraction of interstitial fluid in the brain by hypertonic solutions intravenously and by bowel will yield additional space. This space is available for the return of circulating blood so vital to the maintenance of the life of the patient as well as the subsequent recovery of cerebral function.

One need not go beyond this obvious fact to justify the use of methods which diminish the extracellular fluid volume component of the brain cavity. It is only a question of how frequently these methods of spinal drainage and dehydration should be used and what the criterions are for their use.

In our experience *pulse pressure* is the outstanding index as to when cerebral circulation is becoming embarrassed and oxygen delivery to the brain is beginning to fail. In order to obtain this index blood pressure readings must be recorded at fifteen minute to one half hour intervals in order that a comprehensive analysis may be made. The systolic and diastolic readings must be accurate. Subtraction of the diastolic from systolic pressure yields *pulse pressure*.

If a human life depends upon these accurate readings of pulse pressure as it frequently does in my opinion in order that intelligent treatment may be possible then it is necessary to train the nurses, orderlies or members of the family to take blood pressure if the physician himself cannot devote the time required.

The normal pulse pressure should be 40 mm Hg. As pulse pressure approaches 50 and extends toward 60 it indicates an increasing anemia of the brain irrespective of the spinal pressure. In other words a *rising pulse pressure* is Nature's first defense or alarm and should be answered by measures to increase oxygen availability or blood volume circulating within the cranial cavity by any means that the clinician can logically employ. It therefore becomes in head trauma the index as to when the *next lumbar puncture or spinal drainage may be required* one hour, three hours, ten or twenty four hours etc. following the injury. It also becomes the index of progress in cerebral edema with or without increased spinal pressure. It

becomes the index which indicates a failing cerebral circulation before the crash occurs. Hence, it has been our policy to accurately and frequently chart the pulse pressure and act accordingly. When pulse pressure *falls* toward 30 or below, it will be found that the patient is approaching incompatible levels by the route of vasomotor failure. This is the usual sequence to uncontrolled and profound cerebral anemia usually secondary to edema. Heroic measures are required in this phase not only to increase the volume of space within the skull by any means (decompression, hypertonic solutions by vein or bowel, spinal drainage) but in addition, appropriate cardiovascular stimulants must be employed to avert the oncoming disaster.

Careful consideration must be given to the question as to whether oxygen is being received sufficiently into the lung bed (mucus in the throat, tongue relaxation, compression of the lungs or pneumonia) and the addition of oxygen as well as stimulation of the cardiovascular mechanism may also be required to deliver sufficient oxygen to the brain, even if space were available, as obtained by methods of dehydration or decompression.

In the last analysis, the clinician must free himself from the old superstition regarding the brain as a mysterious organ and treat it as one would other tissues of the body. That it talks, thinks and moves the muscles is only an expression of its intrinsic activity. It requires the same basic consideration as if it were liver, kidney or skin. If its tissues can be maintained alive during the crisis, a prompt return of function will follow to a far greater degree than has formerly been recognized.

If the clinician were to continually ask himself one question and logically follow the methods at hand to assure the answer, the various angles of the problem would probably be well maintained. The question which should ever be before the clinician's mind is, "Is there sufficient oxygen being de-

sciousness may persist for days, survival and recovery usually follow to an eminently satisfactory degree

In summary of all the clinical findings I lay the greatest stress upon *pulse pressure* as a reliable guide to treatment

SURGICAL CONSIDERATIONS

One may dismiss compound wounds of the brain with the general statement that they must be treated like compound wounds in other parts of the body debridement careful cleansing of the wound and attention to the normal reparative processes with removal of foreign fragments are the first steps to be undertaken following the recovery of the patient from shock. Attention to bleeding and the usual toilet of the wound are paramount even if this requires removal of the exposed macerated brain tissue. The coincidental cerebral trauma is then treated along the lines suggested above with the exception that the question of infection requires careful weighing of the program of spinal drainage in view of the fact that organisms may be encouraged into the deeper structures by this means. Hexamethylenamine should be given in doses of 10 to 20 grains four times a day as an adjunct to prevent infection of the subarachnoid space and this drug should be routinely employed where fractures of the base of the skull may open into the air sinuses.

Hemorrhage and clot may be considered briefly. A clot whether formed or diffuse in the subdural and epidural spaces or within the substance of the brain may require surgical relief depending upon the volume which it occupies at the expense of blood circulation. Even though subdural hemorrhage may be present and definitely established by focal neurologic signs or demonstrable by x ray in the shift of the pineal body nevertheless if the patient can be maintained for from five to even days in a satisfactory condition by withdrawing sufficient fluid to compensate for the volume occupied by the clot operation upon the clot is highly favorable after the fifth day and the best results are obtained if delay is maintained until at least the tenth to fourteenth day following injury.

Early operation is required where evidence of progressive symptoms arises in spite of the corrective measures used. Only too frequently the

of the actively swelling brain will present complications of pressure and bleeding that are not present five to seven days later

The surgeon should operate at the location of the cerebral centers responsible for the progressive or focal signs as established by a careful neurologic examination irrespective of whether a fracture of the skull occurs over this area or extends even on the opposite side. Contrecoup lesions and clots may be present in about 40 per cent of cases and the surgeon who operates on the fracture line alone will probably miss many important lesions. Frequent careful neurologic examinations are therefore imperative.

Progressive weakness of an arm or leg is important. Progressive weakness of the face, arm or leg is highly important. Dilatation of the pupil generally occurs on the side of the lesion if the clot be located in the anterior part of the middle fossa over the temporal lobe or around the frontal lobe.

Aphasia must be carefully distinguished from stupor. Frequently the patient because he cannot speak or understand is said to be stuporous but in reality the lesion is a focal one concerning the auditory speech centers. The opposite hemisphere of the brain will be found to be intact and functioning. *Stupor* must be considered as dysfunction of the brain as a whole and is usually due to profound anemia whereas *aphasia* will be found to be associated with a focal process in which the

mediate exploration where subdural hemorrhage is suspected and if not found at the point of opening operation then undertaken upon the opposite side. This is a hit or miss policy.

It is only occasionally that a careful neurologic examination will fail to reveal evidence of the site of the lesion. Promis

cuous trephining of the skull is therefore a direct comment upon the neurologic acumen of the clinician or his failure to call for the necessary neurologic consultations before entering upon the hazards of surgery. When honestly in doubt about the location of a lesion bilateral trephine is necessary on the theory better safe than sorry.

SUBARACHNOID HEMORRHAGE

A large majority of severe cerebral trauma cases show bloody spinal fluid and thus bleeding occurs within the subarachnoid space which is entirely separated normally from the subdural space and hence receives no blood extravasation unless a dual lesion occurs: i.e. rupture of the arachnoid and escape of subdural blood into the subarachnoid space.

Subarachnoid hemorrhage may or may not be combined with subdural hemorrhage. A clear cut case of subdural hemorrhage can occur without bloody spinal fluid.

Subarachnoid bleeding entails two primary problems. Blood in the subarachnoid space produces a violent reaction of the meninges (Weed) and greatly disturbs the mechanism for spinal fluid elimination for seven to ten days; hence what spinal fluid is being produced will find difficulty in escaping and must be withdrawn by lumbar drainage at appropriate intervals or the patient should be maintained on a fluid level so low that this excess of fluid is not produced (i.e. between 20 and 30 ounces of liquid per day by mouth). Not only does bloody spinal fluid alter the ability of the filters to maintain their normal function but withdrawal of spinal fluid is paramount to favor the clotting of the vessel which may be responsible for the bleeding. This vessel may be situated anywhere within the subarachnoid system and hence is not localizable.

The neurosurgeon recognizes that it is not possible to control bleeding from a small artery which empties directly into a cerebrospinal fluid lake whether it be in the spinal canal, ventricle or in the large cisternae of the brain. It is necessary to withdraw the free fluid which dilutes the blood from around the vessel to promote clotting or if this is not possible a piece of cotton or a small bit of muscle will promptly assure an adherent clot. Spinal fluid delays clotting and hence the withdrawal of spinal fluid favors the approximation of the surfaces

of the brain about the bleeding point, with consequent clot formation. This is directly opposed to the average concept of such a mechanism, as most clinicians have feared that with drawal of spinal fluid would favor an increase in the bleeding. In this respect they follow the reasoning that when the pressure and fluid accumulation have become sufficient to shut off the bleeder, the hemorrhage will be improved. When pressure and fluid have become sufficient to cut off bleeding from a severed arterial branch, similar vessels throughout the brain have been equally compressed to the great disadvantage of the brain as a whole. This policy is similar to that of starving out an entire city to subdue the activities of a single undesirable inhabitant. The bleeding will most assuredly cease when the brain is close to a complete cerebral anemia. This however, is in violation of all fundamental principles of surgery or common sense.

In several of my own experiences, where repeated spinal drainage indicated that continued bleeding existed, I have introduced 5 to 20 cc. of air into the spinal canal and found that it promoted immediate clotting. The subsequent spinal drainage showed a decrease in the red cell count of the fluid, with prompt recovery of the patient.

As fear of increasing the bleeding is the favorite argument against spinal drainage in the trauma case it is well to point out the logical means of dealing with this condition as well as the reasons for their groundless fears. The proof of the matter from a clinical standpoint lies in the fact that we have by its full and repeated use been able to maintain a mortality 25 per cent below that reported from the clinics of those who argue against it. The record shows clearly that it becomes a *dan*

tention carry serious consideration

THE HOPELESS GROUP

This group in our series is represented by approximately 12 per cent of cases. Approximately 4 per cent fell heir to complications such as pneumonia and pulmonary edema as well as occasionally meningitis, secondary to a fracture through the base of the skull or a compounding injury.

Autopsy revealed in 8 per cent of cases that widespread and diffuse injury to the brain substance had occurred. In the majority of instances the force of the blow had been projected in the direction of the pons or medulla, that is, diagonally across the skull and directly through the substance of the vital parts of the brain where no means of relief have been adequate, as hemorrhage and edema in these vital parts bring about an early loss of the vasomotor, cardioregulatory, thermal and respiratory centers.

There are certain clinical rules which have been evolved through experience that are important to us in our attempt to maintain a method of treatment which has brought forth so far, the lowest mortality in this type of case.

- 1 The patient must be adequately treated for shock before any other procedures are to be considered.

- 2 Careful temperature, pulse and respiratory rate, and blood pressure readings must be instituted from the moment of admission.

- 3 Diagnostic spinal puncture and drainage if necessary should be undertaken as soon as the patient is out of shock (Pressure, character of fluid and the amount available determine the methods of treatment).

- 4 A careful neurologic examination with subsequent examinations becomes a matter of routine procedure.

- 5 The patient's fluid balance is well established, not only by the control of fluid intake but by the withdrawal of excess of fluid through spinal drainage or hypertonic solutions by veins or bowels.

- 6 Hexamethylenamine is advocated for all cases where a possible fracture through the base of the skull might have occurred. This medication, however, has been found to be of no avail after infection has occurred. In our series we have come to firmly believe that it is prophylactically responsible for the almost entire absence of complicating meningitis.

- 7 x Ray of the skull should not be undertaken until the patient is entirely out of shock or in a favorable clinical state, whether this delay necessitates waiting for one to ten days, with two exceptions.

- (a) Compounded, comminuted fractures of the skull where surgery may be required for the sake of proper debridement.

of the brain about the bleeding point with consequent clot formation. This is directly opposed to the average concept of such a mechanism as most clinicians have feared that with drawal of spinal fluid would favor an increase in the bleeding. In this respect they follow the reasoning that when the pressure and fluid accumulation have become sufficient to shut off the bleeder, the hemorrhage will be improved. When pressure and fluid have become sufficient to cut off bleeding from a severed arterial branch, similar vessels throughout the brain have been equally compressed to the great disadvantage of the brain as a whole. This policy is similar to that of starving out an entire city to subdue the activities of a single undesirable inhabitant. The bleeding will most assuredly cease when the brain is close to a complete cerebral anemia. This however is in violation of all fundamental principles of surgery or common sense.

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As fear of increasing the bleeding is the favorite argument against spinal drainage in the trauma case it is well to point out the logical means of dealing with this condition as well as the reasons for their groundless fears. The proof of the matter from a clinical standpoint lies in the fact that we have by its full and repeated use been able to maintain a mortality 25 per cent below that reported from the clinics of those who argue against it. The record shows clearly that it becomes a *dangerous procedure* to delay or refute the advantages of spinal drainage in the trauma case and not until those opposed to its proper use show a mortality under 11.5 per cent will their contention carry serious consideration.

THE HOPELESS GROUP

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been found to be responsible for the frequent onset of delayed stupor and the loss of patients who otherwise could have been saved had the clinician recognized the properties of this hypertonic solution. The favorable use of glucose is dependent upon the state of the *blood volume*. During shock, when blood volume is low, glucose favors movement of fluid into the vessels, thus assisting in the raising of blood pressure as well as dehydrating the tissues including the brain. If, however, blood volume reaches its former *normal* state after one or two administrations of hypertonic glucose solution, then, as blood volume has no further need of this fluid, it is almost certain to be unfavorable to the patient to again resort to the further use of glucose. With a full blood volume, fluid is easily available for storage in the tissues.

In order to avoid the secondary edema reaction of glucose it is necessary to again deplete blood volume and curtail liquid by mouth or bowel. The blood volume was depleted during the mechanism of shock by rapid loss of blood plasma and fluid into the interstitial spaces and onto the skin surfaces. This fluid loss from blood volume must be made up either from the tissues or the clinician be required to add a *small* quantity (100-500 cc) of normal saline solution to assist in the process (if the patient is thin and dehydrated more may be required). Hypertonic glucose will greatly assist in overcoming the period of shock by reestablishment of blood volume.

If the patient be a fat, 'hydrated' type, fluid may be reclaimed from his own tissues without the need of additional saline, thus preventing subsequent excess of fluid to be dealt with during the period of brain edema. In this type of patient these body reservoirs are full and ample to meet the needs of blood volume, if mobility of this fluid can be accomplished.

When blood volume has returned to its normal state, however, and it still becomes desirous of subtracting more fluid from the tissues, especially the brain the clinician has recourse to the use of magnesium sulfate by bowel or mouth which will again reduce blood volume (sweating and venoclysis will accomplish the same end).

Having diminished the blood volume a second time, *then* hypertonic glucose solution, intravenously, will act favorably in that it will draw fluid into the blood volume to replace its

of the wound and the localization of bone fragments or foreign particles

(b) Where subdural hematoma is suspected an x ray of the pineal position will frequently be of real assistance

x Ray evidence of a skull fracture is usually only of medico-legal importance Fracture lines disclosed are frequently misleading as to the location of the most profound area of brain

for the degree of brain injury, irrespective of the size or location of the fracture Many patients have been saved because attention has been focused on the need for the immediate treatment of shock as well as the care of cerebral tissue, rather than permit the loss of valuable time merely to satisfy the curiosity of the physician or family as to whether a "fracture of the skull" has occurred

I have seen patients with large fractures of the skull with few or no cerebral symptoms, I have seen many cases where no demonstrable fractures by x ray could be shown, with the most profound cerebral injuries and manifestations In the end, the neurologic examination will determine the location of the most important areas of involvement and only rarely is the surgeon required to seek immediate x ray assistance for the possible location of a lesion

HYPERTONIC GLUCOSE SOLUTION

In closing let me stress the factors concerning the intravenous use of 50 per cent hypertonic glucose solution Hyper

of the glucose solution much of the substance has found a storage place in the tissues the highest points of storage being in the liver and the brain With the burning of some of the

hours following trauma Follow up studies indicate that only 6 per cent of our series have shown permanent or continued disability

Many patients who formerly would have been considered total economic and mental losses are continuing in high positions of mental activity today free from symptoms These results are attributable only to the fact that the first and fundamental principles regarding the maintenance and repair of tissue have been consistently followed that is sufficient oxygen and blood supply has been assured to the brain during a period of trauma and dysfunction so as to permit subsequent and adequate recovery

It is impossible to outline measures which will fit every particular problem The basic considerations are not new they are the basic considerations of all trauma with the proper application of the laws of physics and hydraulics under the peculiar circumstances that surround the brain

Treatment must be varied to suit the needs in each case Too much dehydration treatment may be as unwise as too little The fluid needs of the body must be worked out as one does the dose of a drug The proper dose of a drug or fluid is *just enough*

The methods of treatment indicated above have been evolved through a logical program of analysis The former concepts surrounding the *do nothing* policy are shown to be unwarranted in this modern day of medicine

In my opinion the day is not far distant when the public will not tolerate a mortality above 20 per cent in this problem Already the safety measures legal penalties and public campaign against this high accident and death rate are beginning to challenge the medical profession

We have within our means methods of offsetting this appalling yearly public loss

The industrial accident groups the insurance companies and social units concerned with this problem become more and more involved In the end this problem primarily concerns the medical profession

Let me commend you to the early surgical teachings and principles laid down by Ambrose Pare You will find that over three hundred years ago he advocated the restriction of

recent loss and there will be less likelihood of the secondary phase of edema mentioned above

In my own experience it has rarely been necessary to use more than 2 injections of 50 per cent hypertonic glucose solution but where necessary the above precautions have been taken and in recent years since this mechanism has been more clearly understood the uncertain secondary results of glucose have been eliminated almost entirely

The pulse rate serves as a fair index as to the state of blood volume. As a rule, 'when the pulse rate is over 120 it is the cry of the circulation for more volume (exceptions hyperthyroidism hyperthermia and certain emotional states)

Careful records of the pulse rate will indicate when the measures of dehydration may have been carried too far. Where active dehydration may be required in the plump well nourished group it may be unnecessary or even harmful to the thin emaciated types. In this thin group reserve tissue fluid is lacking and blood volume may have to be maintained by forcing fluid. Under these circumstances the brain can be protected by frequent spinal drainage

SUMMARY

There can be no question about the supportive evidence as presented through Mock's survey and the reports of Swift and others who have followed these basic principles of treatment

The beneficial results have been derived from strict adherence to the fundamental principles of surgery and certain laws of physics and hydraulics concerned with an organ subjected to the forces of hydrodynamics within the unyielding confines of the skull

The present mortality figures not only indicate that approximately 25 more out of every 100 who have sustained severe injury to the brain may survive but the improvement noted from the standpoint of subsequent economic and social adjustments is remarkable. It is now possible to return patients to full activity within a three month period if the circulation to the brain has been properly protected in the early

hours following trauma Follow up studies indicate that only 6 per cent of our series have shown permanent or continued disability

Many patients who formerly would have been considered total economic and mental losses are continuing in high positions of mental activity today free from symptoms These results are attributable only to the fact that the first and fundamental principles regarding the maintenance and repair of tissue have been consistently followed that is sufficient oxygen and blood supply has been assured to the brain during a period of trauma and dysfunction so as to permit subsequent and adequate recovery

It is impossible to outline measures which will fit every particular problem The basic considerations are not new they are the basic considerations of all trauma with the proper application of the laws of physics and hydraulics under the peculiar circumstances that surround the brain

Treatment must be varied to suit the needs in each case Too much dehydration treatment may be as unwise as too little The fluid needs of the body must be worked out as one does the dose of a drug The proper dose of a drug or fluid is *just enough*

The methods of treatment indicated above have been evolved through a logical program of analysis The former concepts surrounding the do nothing policy are shown to be unwarranted in this modern day of medicine

In my opinion the day is not far distant when the public will not tolerate a mortality above 20 per cent in this problem Already the safety measures legal penalties and public campaign against this high accident and death rate are beginning to challenge the medical profession

We have within our means methods of offsetting this appalling yearly public loss

The industrial accident groups the insurance companies and social units concerned with this problem become more and more involved In the end this problem primarily concerns the medical profession

Let me commend you to the early surgical teachings and principles laid down by Ambrose Pare You will find that over three hundred years ago he advocated the restriction of

fluid in his patients following head injuries in conjunction with purgation and sweating. He did not have at his command the procedure of spinal puncture and drainage but yet the mortality in his large group of cases suffering cerebral injuries during a war time period was lower than the general average in the peaceful days of our modern United States.

We may turn back with profit to the simple fundamental surgical principles which he espoused. Disregarding the mystery and dominance of the brain as a supreme organ its survival and function depend upon an adequate supply of blood and oxygen. Any method which will further this end will find its true measure of benefit in the problems which involve its survival.

CLINIC OF DR. V. W. MURRAY WRIGHT

JEWISH HOSPITAL¹

PRACTICAL FRACTURE PHYSICAL THERAPY

THE reduction and proper immobilization of a fracture, while concededly of considerable importance, is invariably the least time consuming part in the treatment of a fracture case. Then, too, many fractures require no reduction and but little immobilization.

Over a period of years in teaching and practicing in surgically active hospitals, the writer has come to the conclusion that the average physician and surgeon overimmobilizes fractures and pays scant, or late, attention to mobilization. Many a student, and occasionally a physician, has asked what mobilization means. Apparently they had heard much of immobilization but nothing of the teachings of Lucas Championniere who in the 1800's, advocated early mobilization of fracture cases.

Lucas Championniere, and our preceptors who labored before the x ray was invented, often secured better results with their fracture cases than modern physicians who use both the fluoroscope and x ray. The old time

knew it was present by their ability to test for "clinical union." These physicians treated the patient and not the x ray film. Far too often at the present time, one sees physicians con-

to apply and when to discontinue immobilization.

¹Formerly in charge (1924-1937) of the Fracture Division of the Surgical Dispensary of the University of Pennsylvania Hospital.

To students and interns I have often remarked that physical therapy *should begin before the fracture was reduced, not after it had united*. This may seem like a very broad statement and perhaps a radical one. Personally, I regard it as the most conservative of treatments though not *always* practical of application. Nevertheless, the concept is an excellent one to bear in mind, to practice and to teach—always.

For example, when one has the good fortune to see a fracture case within half an hour of its inception, the affected parts are distorted and awry due to the flaccidity of the associated



FIG. 469.—Palmar plaster molded splint for wrist and carpal fractures. This is an open type of splint which permits the early application of physical therapy.

muscles. This relaxed condition is due to local shock always and to general shock occasionally. During the twenty to thirty minute interval following a fracture there is, as a general rule, no local pain. Many an injured person has performed astonishing things for a short period of time with a fractured extremity—due to this painless period.

As local shock recedes and general shock if present abates, pain manifests itself and the associated muscles reflexly go into spasm to protect the injured parts from further damage. It is nature's own way of immobilizing a fracture.

Readers will recall how easy and without anesthesia it is to reduce these acute fractures. When a fracture case is seen immediately after this brief flaccid state it is then necessary to relax the protecting spastic muscles with a relaxing anesthetic. Not infrequently I have treated twenty four hour old fractures of the wrist and ankle by first spending ten to fifteen minutes in massaging to relax the spastic muscles and then reducing the fracture without an anesthetic. This was physical therapy applied before the fracture was reduced—not after it had united.

There are many fractures which can receive simple physical therapy (gentle heat and massage) daily after reduction. However it can only be applied to those fractures which are capable of being treated by (and if the attending physician will adapt) open types of immobilization (Fig 469).

By the open type of splinting the writer refers to those types of retentive support whereby the fractured part is always visible and accessible to the attending physician. Such examples are

- 1 Sayre dressing for fractured clavicles
- 2 Horse collar type of dressing for elbow fractures excepting the olecranon
- 3 An axillary pad wrist sling and adhesive strap for most fractures of the upper humerus
- 4 Palmar plaster splint or Bond splint for Colles fracture (Fig 469)
- 5 Russell traction for fractures of the femur where it is applicable
- 6 Skeletal traction and Thomas splint for fractures of the femur requiring traction
- 7 Posterior molded plaster splint for fractured patellae
- 8 Lateral molded plaster splints to the leg and ankle for suitable cases
- 9 Adhesive strapping for simple ankle fractures
- 10 Adhesive strapping for simple tarsal and metatarsal fractures

Out of sight out of mind is frequently the rule when a solid plaster cast is applied. Certainly it is out of bounds as far as applying physical therapy. When really necessary casts should of course be applied but the fact that many sur

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PRACTICAL PHYSIOTHERAPY EXERCISES

Injured part	Motion to be restored	Restoration exercises
Fingers	Flexion and extension	Practicing piano playing Rubber ball water pistol sponge newspaper
Wrist		

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Arm	Abduction	
	Circumduction Internal and rotation	
Jaw	Flexion and extension	Chewing gum
Neck	Flexion and extension Rotation	Toss head back and bring chin to chest Look over right and left shoulders
Clavicle	Gliding and circumduction	Swinging a pall in a circle over head
Spine		

		Hips Swimming
Hip or pelvis	Circumduction	
	Abduction and adduction	
		Abduct other

Knee and leg	Flexion and extension	In bed bring knees to chest. Later climb stairs along rail Back leg when reclining
	Internal and external rotation	In bed or chair simply rotate leg On weight bearing pivot on leg

geons who are interested in fractures only infrequently resort to their use should demonstrate that they are not as often necessary as they are applied. If the readers will preach and practice open types of splinting more often they will enable their confreres assistants and interns to practice early physical therapy because the injured parts will be accessible to early and better physical therapeutic measures.

PHYSICAL THERAPEUTICS

Among the physical therapeutic measures which we have available today are heat massage active and passive motion also electric stimulation diathermy radiant energy trained

been and
use them

regardless of where the physician or patient may be—these are the fundamental agents for restoring function. When the patient and the physician are in an institution or locality where the other procedures are available then they should also be used if required.

So often it seems the attending physician is left on his own to shift as he will or as he can in applying fracture physical therapy. In such instances he should apply an electric pad (available almost anywhere) to the affected part turned to the lowest heat. Usually an application of an hour of such heat three times daily is sufficient. Gentle massage at first (as gentle and soothing as the stroking of a fevered brow) and deeper massage later will tend to keep the associated muscles tendons and circulation in a nearly normal state. Later passive motion and *guided* active motion should be resorted to individually as each case permits and deserves. For guided active motions cases will progress more rapidly if the attending physician has in mind at or before reduction the limitations of motion which are bound to result in the individual fracture case so that appropriate physical therapy exercises may be used early to restore the injured person to his normal status in a minimum period of time. To this end there are some appended suggestions which though doubtless already familiar to various readers will perhaps prove of some value to the uninitiated. Before taking up the specific

the metacarpophalangeal joints. The latter length of splint leaves the fingers free for exercising (Fig 469). The wet molded splint is made with a 1¹/₂ inch gauze bandage.

At the end of twenty four hours the splint is gently removed and 3 straps of 1 inch adhesive are substituted for the initial bandage used in applying the splint. The dressing is now an 'open type' one and the part is accessible to inspection, heat and massage.



Fig 470—Illustrating the case of applying gentle massage to a fractured wrist either by the patient, the physician or both.

On this initial revisit gentle massage is given and the patient is instructed to gently stroke the back of the hand and wrist for a period of five minutes three or four times daily (Fig 470). The application of an electric pad (turned low) is recommended for half hour intervals two or three times daily.

The patient is seen by the physician every two or three days in the early part of the treatment. On these visits the splint is gently removed, the hand kept in palmar flexion and massage given to both aspects of the wrist and forearm. After four to six days gentle passive flexion and extension are given to the wrist with gentle supination and pronation.

PRACTICAL PHYSIOTHERAPY EXERCISES

Injured part.	Motion to be restored.	Restoration exercises
Foot.	—	
Toes.	Flexion and extension.	Place towel on floor and move it lengthwise by crabbing with toes. Try to pick up a pencil with toes. Go up on toes and down again.

minutes

exercises applicable to fractures in general. I will outline the author's personal treatment of one of the most common fractures we have to deal with.

Treatment of a Colles' Fracture—If seen within twenty-four to thirty-six hours after the fracture has occurred the injured hand is held in the flexed position cradled in the left hand of the physician. The posterior surface of the hand, wrist and lower half of the forearm is then gently stroked for five minutes. The ventral surface is then treated similarly. The extremity may now be rested on a table surface or in the lap and the extensor and flexor muscles gently kneaded until they are relaxed.

The fracture is then reduced with or without anesthesia by securing a firm handclasp grip of the injured hand and while firmly holding the lower forearm with the left hand the surgeon—using traction with his right hand—quickly flexes and extends the fractured site one or two times and jerks it into position. The hand is then placed in palmar flexion on a molded plaster-of-paris cock-down splint placed on the ventral aspect only and running from just below the elbow down to

tion of the thumb, and reflexly, some defensive disuse of the wrist

To correct the primary trouble it is only necessary to teach the patient some simple, elementary or practical exercise which will reinstitute flexion and extension of the fingers and which will, at the same time, restore strength to the muscles that have become weak from disuse

Such simple and practical exercises may be 'practicing piano playing,' wherein the patient rests his hand and wrist on any flat surface and pretends that he is playing a piano For five cents any person may purchase a soft, hollow rubber ball which he or she may carry in their pocket or handbag and, taking it out on innumerable occasions during the day, squeeze it flat for several minutes until their wrist muscles ache Later, when the hand is rested, one may repeat the exercise Children will enjoy 'getting well' and accomplish the same results, if the doctor advises the parents to provide the injured child with a rubber handled water pistol With the latter the youngster may annoy his relatives and playmates by squirting water at them, but in so doing he flexes and extends his fingers—restoring their motion and function Still another exercise is to squeeze a sponge either dry or immersed in a basin of hot water and watch the bubbles come up to the surface The latter will amuse children and the hot water will stimulate the sluggish circulation of elderly patients A most excellent exercise for regaining motion and strength in unused fingers is the 'newspaper exercise' which will be described under wrist fractures

Fractures of the Carpal Bones and Wrist Joint—Fractures of the wrist joint area primarily cause limitation of flexion and extension of the wrist joint as well as abduction and adduction of the same Secondly there is reflexly a loss of motion of the movements of the fingers Lastly and frequently overlooked by the attending physician there is a loss of pronation and supination of the forearm If anyone doubts this statement let him in his next 10 cases of wrist fracture perform this simple test ask the patient to place both elbows tightly at his side flex his forearms at right angles to his arms or body, and with his hands extended toward you Then ask him (still hugging his elbows to his sides) to rotate *both* hands until his

The patient is encouraged to "practice piano playing" with the uncovered fingers, at home. The splint is then discarded in from ten to twenty days depending upon the age and the extent of the fracture. Rarely have I ever maintained a Colles' fracture on a splint for four weeks or more. Early clinical union is usually present in from seven to ten days, as is evident by the fact that it is ordinarily a difficult procedure to reduce a seven-day-old fracture.

When the splint is discarded, a wrist sling is advised so the hand may be readily withdrawn for exercises and light tasks. As are for ball weeks time, the average person may perform the majority of his daily tasks, unless he is engaged in manual labor.

The patient is encouraged to use the hand as much as possible, up to the point of pain, and then to give it a five to ten minute rest. He is advised that the soreness (not pain) may be *hurting him* but that it is not *hurting the bone* and that the best way to get rid of soreness and stiffness is to "work it out." After all, if it is difficult to reduce a seven-day old fracture and impossible to reduce a three week old fracture, even when the physician "swings on it" under general anesthesia how can the patient disturb the fracture site with less force?

This short period of immobilization may seem too little to some, but if they will test out the above method they will find that they will obtain earlier clinical union because of the improved circulation and physical condition of the fractured site and better condition of the associated soft tissues which all too often are forgotten. Remember always to treat the patient and not the x ray film. There is always more callus present clinically than roentgenographically. Bear in mind "clinical union" as your forefathers did.

SPECIFIC EXERCISES



Fig. 471—Start of the newspaper exercise. Unaided by the other hand the paper is slowly crumpled up.



Fig. 472—Crumpling of the newspaper is continued until it is "palmed" as a small compact ball. This exercise uses every muscle from the finger tips to and including the elbow joint.

It was taught to me by a prize fighter whom I had treated for a party fracture of the shaft of the ulna. He selected a newspaper and taking a double sheet out picked up one corner of

hands are parallel with the floor. Next, ask him to rotate both palms until they are parallel with the ceiling. In every instance it will be observed that the uninjured hand is parallel with the floor on pronation and parallel with the ceiling on supination whereas the injured hand will pronate or supinate only 50 to 75 per cent of the normal. This test may be used at the beginning, during and at the end of a course of physical therapy exercises to measure the progress of the restoration of functional, anatomic and economic results.

The simplest method I know for teaching patients to regain flexion and extension of the wrist is the 'table edge exercise'. This consists of having the patient rest his forearm and wrist on the flat surface of a table, bench or desk so that the hand and wrist may hang freely over the edge—permitting unimpeded flexion and extension of the hand.

Immediately after the discarding of forearm and wrist splints, it may not be possible for the patient to *actively* flex and extend his hand while hanging it over the table edge. However, he may *passively* do so by placing the hand in the proper position and then with the opposite hand (or the physician's) passively move the hand up and down while *actively* trying to contract the appropriate muscles to accomplish the passively helping hand. As the days pass the muscles actively take over flexion and extension until increasingly normal function is restored. Here one has done nothing but educate or rather reeducate, the muscles and their owner to reestablish their proper "mode of living". In simple words the attending physician has done nothing other than teach the patient to help himself get well as quickly as possible. Physicians will find the majority of patients only too eager to follow his simple and practical exercises which will enable them to get back to work and the support of their families in a minimal length of time.

Cases of compensationitis respond of course to nothing other than the soothing palmar touch of gold despite an interested physician's best efforts. In these cases cooperation with the physician is delayed until the patient's *main* desire is accomplished.

An excellent practical exercise that accomplishes many things is termed the "newspaper exercise" (Figs 471-472).

such as the 'poker or broom handle exercise' or the swirling pail exercise

In the former one grasps an ordinary poker (if you can find one in these modern days) or a sawed off broom handle (Fig 473) by its middle and then rotates it and the forearm rapidly to the right and left the speed and the weight of the object with its centrifugal force carrying the hand in each movement into greater supination and pronation than the patient would otherwise have carried it unaided

Pronation and supination of the forearm are rapidly increased by having the patient lift a partially filled pail of water just off the floor and rotate it rapidly to the right and left. If the reader will but try this exercise himself he will note that each time he consciously stops rotating the pail in one direction or the other the centrifugal force of the swirling water in the pail supinates and pronates his hand a bit more than he intended. The latter is just what we wish to accomplish in our fracture cases with limited supination and pronation.

Fractures About and Above the Elbow Joint—Here the primary dysfunction is limited flexion and extension of the forearm with altered pronation and supination. Secondly there may be more distal limitations of disuse. For restoring flexion and extension of the forearm there are various home exercises which the patient may follow in helping you to get him well.

One method is the bucket exercise which aids early restoration of extension. Supposing that the treatment instituted for the fracture of the elbow has not caused him to lose the grip of the fingers he is instructed to start carrying a bucket which contains 1 inch of water on the first day and which is increased by 1 inch of water per day. He is asked to pick up the bucket ten to fifteen times daily and carry it about the room or the house. He is advised that it may cause some of his muscles to ache—naturally—but while it may hurt *him* it will not hurt the *bone*.

In fractures about the elbow joint the greatest dysfunction resulting therefrom is usually that of flexion. The best way of overcoming this is to prevent it by dressing the fracture in acute flexion whenever possible. Excepting fractures of the olecranon the so-called horse-collar dressing is ordinarily

it with the fingers of his uninjured hand and (unaided by the other) proceeded to crumple it up until he had succeeded in 'palming' it into one small, compressed, hard wad. He insisted that I try it which I did and found that I (and most untrained people) could only palm a single page. I also learned, as he assured me that it will give to any person who practices it daily a grip such that, when the exerciser shakes another person's hand the recipient knows that his hand has been shaken.



Fig. 473—Seizing a poker or broom handle by its middle the object is rapidly rotated to the right and left. Note the supination and pronation accomplished by this exercise.

Subsequently I have learned that it is impossible to carry out this exercise without using all of the muscles from the elbow down and performing all the functions and motions of the fingers, wrist and forearm including pronation and supination. The reader may simply attest this statement by a personal trial.

Fractures of the Forearm—Primarily pronation and supination are the motions most affected. Secondly there

dary dysfunction one of two other exercises may be utilized

Fractures of the Shaft and Upper End of the Humerus.—The limitations of motion resulting from fractures of the humerus above the supracondylar level are mainly those of internal and external rotation circumduction and of abduction. Secondly there may be some decreased motion of the forearm such as pronation supination flexion and extension. The latter are corrected by the exercises previously mentioned under forearm and elbow fractures.

Internal and external rotation are readily restored by having the patient stoop and after raising a partially filled water pail just off the floor rapidly rotate it to the right and left. Such a patient has difficulty at first in scratching his lumbar area or putting his hand in his hip pocket. He should be encouraged to do both.

Limited circumduction is best overcome by having the injured person swing his extended arm in a wide arc perpendicular to the floor. Ordinarily he is unable to do this until he has partially regained some abduction.

Directly after the discarding of immobilization patients may not be able to abduct the arm due to the atrophy of disuse of the deltoid muscle which accompanies the stiffened joint.

These patients are often able to abduct their arms when lying down but not when standing up. Consequently they should be encouraged to lie on a bed or the floor and abduct their arms (passively and actively) while pretending to comb or smooth down their hair or to scratch their heads. Once they have acquired some power of abduction they should be advised to stand as though taking setting up exercises and using both upper extremities to thrust *both* hands quickly toward the ceiling and then down again. The momentum gained in the thrusting will usually carry the arm higher than were they to do the same thing slowly.

The wall crawling exercise (Fig 475) is quite beneficial in regaining abduction and elevation of the arm. It consists in having the patient stand facing a wall with his toes about one foot away from the baseboard and then resting both hands upon their fingertips—upon the wall directly in front of each shoulder. Using both hands the patient now crawls up the wall as far as he can reach. This he should do ten to fifteen times every one or two hours.

applicable. By dressing the part in flexion one has prevented loss of that motion.

When there is decreased flexion of the forearm the patient should be taught simple exercises such as "pretending to comb the hair" (Fig. 474), "making a muscle," etc. Until a patient has lost the ability to acutely flex his forearm he does not realize how very important this motion is in ordinary life. Unless one can acutely flex the forearm it is impossible for him to tie his tie, shave, fasten a collar button, comb his hair or carry a glass of water or cup of coffee to his lips.



Fig. 474.—Illustrating the pretending to comb the hair exercise. Note the acute flexion of the forearm gained in this exercise.

If the patient has a convenient trapeze bar or athletic rings suspended in the cellar he may grasp it with both hands and then, letting the knees sag slowly, gradually ease the weight of his body upon the upper extremities, thus straightening the arm out. This can be repeated ten to fifteen times daily.

To restore flexion of the forearm the patient may exercise

ribs especially when there have been multiple fractures of the ribs. If deemed advisable the patient may be coached how to use a blow bottle or to blow soap bubbles.

In connection with fractures of the ribs it is interesting to recall that such fractures (when uncomplicated) give us and the patient the least trouble of any fracture in the body yet fractured ribs are *never completely* immobilized. To a less extent this is also true of a fractured clavicle.

No matter how firmly we may strap a chest wrinkles will appear in the adhesive in from forty eight to seventy two hours and when wrinkles are present in adhesive straps we have only partial immobilization.

I believe scientifically that we can safely say that it is ordinarily impossible to completely immobilize half the chest with the ordinary method of strapping with adhesive. If this be so then considering the rate of 18 respirations per minute a fractured rib moves (slightly) 1080 times per hour 25 920 times per day 181 440 times per week or 518 400 times during a period of twenty days of immobilization—over half a million times. Who has ever heard of an ununited simple fracture of the rib? Perhaps fractures in ribs like those in wild animals heal excellently because they are not overimmobilized.

Fractures of the Spine—Due to the prolonged immobilization so frequently necessary in the treatment of fractures of the spine patients are invariably left with what they term a stiff spine and stiff it usually is in more ways than one. Difficulty in flexing the spine (anteriorly) is more noticeable than is extension as they are ordinarily mobilized in extension and because normally we need and practice flexion most in an active way. Extension of the spine in health is most of the time a passive affair. Lateral flexion is of course impaired as is lateral rotation.

Due to the prolonged bed treatment patients with a fractured spine are frequently unable to walk after the removal of their casts due to the atrophy of disuse of the muscles of their lower extremities. Even supposing they have received good physical therapy to their lower extremities while they have been lying in bed it will still be some time nevertheless before they are capable of unaided navigation after their cast is removed.

This interval period is an excellent time to begin the re

Fractures of the clavicle may limit abduction and circumduction of the arm in middle aged and elderly individual. Should this occur the above exercises will restore the lost or limited motions.

Fractures of the jaw naturally cause limited extension and flexion of the jaw. This is easily and pleasantly overcome by encouraging the patient to chew gum or slippery elm bark.

Fractures of the cervical vertebrae result in decreased flexion, extension and rotation of the neck. The first two are



Fig. 475.—Wall-crawling exercise. The injured right arm is attempting to crawl up the wall as high as the uninjured one, thus restoring normal abduction and elevation.

overcome by alternately attempting to touch the chin to the chest and then tossing the head backward. To increase rotation directions should be given to look first over one shoulder and then the other.

Fractures of the Ribs and Sternum—Fractures of the sternum may give the patient a sensation of constriction of the chest as though he cannot take a deep breath. However by practicing deep breathing exercises this sensation soon disappears. The same may be said of certain cases of fractured

and electric stimulation in selected cases providing the individual has been treated with open types of immobilization: *i. e.* Balkan frame, Thomas splint, and skeletal traction. However, if plaster dressings have been used or if the location of the patient and the available armamentarium is not conducive to this ideal state of physical therapy the average physician finds the typical case in the typical condition following the abandonment of retentive paraphernalia—namely weakness and stiffness of the associated muscles ligaments and joints.

When the patient is in an institution or situation where various physical therapy accessories such as diathermy infra red lights sinusoidal current expert massage and passive motion given by trained physical therapists are available these agencies conduce to a rapid restoration of functional economic and anatomic results.

Unfortunately however I believe that the majority of readers will find that usually they must adapt the situation to a practical rather than an ideal physical therapeutic state of affairs. To this end it is best to instruct relatives and friends (when the patient is at home) or the attending nurse otherwise to daily massage the calf thigh hip and lumbar muscles preferably after one half to one hour's application of an electric pad which can now be purchased nearly anywhere for \$2.

The writer has long since abandoned hot wet dressings unless a *private* nurse is in attendance whether in private or hospital practice as it will be found by anyone who cares to check the fact that while such dressings are moist about 70 per cent of the time they are hot only 5 to 10 per cent of the time. To a less extent hot water bags (which can create burns) are hot about 20 to 25 per cent of the time. An electric pad turned low is comfortably warm however 100 per cent of the time. A small amount of heat producing gentle and constant hyperemia over a long period of time is infinitely superior to the more rubicund but evanescent warmth of the ordinary hot wet dressing.

In addition to heat and massage there are various passive and active exercises which will benefit the patient and hasten his functional return to normalcy. The reader is referred to the Table on pages 1687 and 1688 for those exercises which have been found to have practical value.

sumption of the normal motions of the spine. Lying in pajamas and uncovered patient is passively taught at first to bring his knees to his chest and to bring his forehead to the knees with a pushing or spring off start by first pushing with his feet against the foot of the bed and then with his forearms and hands which gives him a forward thrust when attempting to flex his spine so that the forehead will approximate the knees.

In addition he should be encouraged to roll from side to side in bed and to pick up objects lying on the floor at the side of the bed especially while lying on the stomach. The latter exercise aids lateral rotation, lateral flexion and extension of the spine.

Once he has become ambulatory he should be instructed to drop handkerchiefs, etc. on the floor in a row and then walk

exercise so commonly used for other purposes.

Lastly for those who have the good fortune to have access to water or to swimming pools swimming is a most helpful and pleasurable way of regaining normal spinal motions.

Fractures of the Pelvis—Fractures of the pelvis are most apt to result in decreased function of the joints above and below the pelvis, namely the spine, hip and knee joints. The calf muscles are bound to be soft unless proper attention has been given them and immediate weight bearing is to the patient surprisingly impossible after immobilization has been discarded. Consequently attention must be directed to restoring the strength of the atrophied muscles and motions in the unused joints. Suggestions for accomplishing this as far as

lization entailed in fractures of the hip joint and femur except when pins, screws, etc. with immediate chair position are resorted to requires a prolonged period of bed treatment with the patient flat on his back and with the thighs and lower trunk muscles taking a prolonged vacation. At the termination of this period they are naturally soft. One can of course prevent some of this by the judicious application of massage

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When the patient is in an institution or situation where various physical therapy accessories such as diathermy infra red lights sinusoidal current expert massage and passive motion given by trained physical therapists are available these agencies conduce to a rapid restoration of functional economic and anatomic results.

Unfortunately however I believe that the majority of readers will find that usually they must adapt the situation to a practical rather than an ideal physical therapeutic state of affairs. To this end it is best to instruct relatives and friends (when the patient is at home) or the attending nurse otherwise to daily massage the calf thigh hip and lumbar muscles preferably after one half to one hour's application of an electric pad which can now be purchased nearly anywhere for \$2.

The writer has long since abandoned hot wet dressings unless a *private* nurse is in attendance whether in private or hospital practice as it will be found by anyone who cares to check the fact that while such dressings are moist about 70 per cent of the time they are hot only 5 to 10 per cent of the time. To a less extent hot water bags (which can create burns) are hot about 20 to 25 per cent of the time. An electric pad turned low is comfortably warm however 100 per cent of the time. A small amount of heat producing gentle and constant hyperemia over a long period of time is infinitely superior to the more rubicund but evanescent warmth of the ordinary hot wet dressing.

In addition to heat and massage there are various passive and active exercises which will benefit the patient and hasten his functional return to normalcy. The reader is referred to the Table on pages 1687 and 1688 for those exercises which have been found to have practical value.

Fractures of the Knee, Leg, Ankle and Foot—Fractures of the lower thigh, of the knee joint and of the upper leg primarily result in decreased flexion and extension of the leg upon the thigh with secondary alterations in the function of the ankle and foot

Fractures of the leg and ankle cause more disturbance of the functions of the ankle and of the foot. The longer the period of immobilization the greater will these dysfunctions be, and *conversely* the shorter the period of immobilization, the sooner mobilization can be introduced through the individual use of "open types of splinting" (i. e., removable, adjustable plaster molded splints), the sooner the patient will be able to resume his normal place in the scheme of life

In addition to the usual applications of the electric pad to the knee or leg, as well as hot immersion baths for the foot and ankle, the various passive and active exercises enumerated in the attached table will not only restore the injured person to work sooner than otherwise, but will make the average patient happier in so doing

COMMENTS

Fortunately, the majority of our patients want to get well. Particularly is this true of the worker—the one who not only has to earn an honest living but has to support the wife and kids. Instruct such individuals in the simple, practical things which he may do at home to aid nature heal him, and you will find a happier and more rapidly convalescent patient. This is borne out by the fact that physical therapy is seldom needed by those rascally youngsters who are forever on the move, hard to manage, the worry of their fretting mothers but the cohorts of nature which is ever in motion—and full of life! These individuals cannot be kept from getting well because they refuse to be overimmobilized. Like wild animals who sustain fractures which are never treated by human hands, nature tells them, and quite honestly, when it is permissible for them to do this or that. Horse sense is all they know, but they use it.

When you immobilize, **IMMOBILIZE!** But do not overimmobilize.

Institute mobilization as soon as it is safe. This is best applied by evidence of clinical union and not by "roentgen

union' The first is early while the second is late, sometimes too late Treat the patient, not the x ray film

Early mobilization conserves function Conserved function does not require the regaining of lost function An ounce of prevention is worth a pound of cure

Abandon solid plaster casts whenever they are not absolutely necessary as they hide the pathology and prevent the maintenance of the normal physiologic state Solid plaster casts, when not indicated usually mean out of sight, out of mind" Certainly they prevent early physical therapy, early mobilization!

Use open types of splinting whenever applicable which is about 90 per cent of the time Open type splinting permits constant observation of alignment the application of mild heat, the institution of early friction or gentle massage and the earliest possible inauguration of passive and guided active motion

Lucas Championniere in 1840-1860 treated fractures before the advent of x rays with better success than his confreres and many physicians of today because he instituted early mobilization and utilized simple practical physical therapy, the same kind that is still available to any and all physicians who have a will or desire to use them—mild continuous heat, friction or gentle massage passive motion and practical exercises Lucas Championniere did not have access to our modern, expensive and often unavailable electric physical therapy apparatus He had only his head and his hands These however he used rather well



CONTRIBUTION BY DR ROBERT R IMPINK, MISS
CLARE S SPACKMAN AND DR WALTER ESTELL
LEE

PHILADELPHIA

THE USE OF OCCUPATIONAL THERAPY IN THE TREATMENT OF FRACTURES

ONE of the many tangible advances in surgery resulting from the World War was the recognition of the importance of rapid rehabilitation of patients suffering from fractures and dislocations. This principle had been enunciated previously on numerous occasions in civil practice but it required the large number of men disabled by fractures and dislocations in the war to bring it forcibly before the consciousness of the average surgeon. The increasing number of motor and industrial accidents at the present time together with the rigid standards of compensation and insurance legislation have kept this phase of fracture treatment in the foreground.

Our aim in the treatment of any fracture is to accomplish an anatomic reposition of the bone fragments without inflicting additional trauma to the damaged tissues and more important to restore the function of the injured part as quickly as possible. Methods of reduction and immobilization are not a part of this discussion. However the restoration of function by the institution of active motions as soon as is consistent with safety is the chief concern of the occupational therapist.

The nature of the pathologic process at the fracture site must be appreciated in order to understand the logic of prescribing active motion in fresh fractures. Torn blood vessels give rise to hemorrhage and destroyed lymphatic channels allow the escape of edema fluid both of which infiltrate the lacerated muscular and fibrous tissues. Inflammatory exudates add to the general swelling. The only mechanism available for dispersing these abnormal fluids from the injured

tissues, before slow absorption and organization into scar tissue occur, consists in the rapid reestablishment of the vascular channels

This fact has been generally accepted during the past few years. The approach to the solution of the problem of restoring the circulatory status of the injured part was made by the introduction of physical therapeutic measures from the beginning of the fracture treatment. In this way the circulation of the surrounding healthy tissues is increased and the growth of new vascular channels proceeding from the periphery toward the center of the injured area is stimulated. Various forms of physiotherapy have been utilized to accomplish this result. The greatest success, however, has followed the prescription of the simplest and most gentle procedures. Elevation of the part to provide the beneficial effect of gravity, constant heat of moderate intensity, light stroking massage and when possible, guarded active motions of the extremity have been found adequate in the early days of treatment. Electric stimulation of muscles is beneficial in preventing muscle atrophy when the injured part is immobilized in plaster, or when active motion is impossible for other reasons. When bone healing has progressed sufficiently to warrant discarding splints and resumption of the function of the part, physiotherapy is still a valuable asset, but it should be used to supplement the treatment which the patient assumes the various and massage to exercise

the stiffened muscles. This point of view is frequently attributable to faulty instructions on the part of the physician rather than to lack of cooperation on the part of the patient. Physiotherapy should be introduced to the patient as a means of accelerating the early stages of the healing process, but it should be used in aid of the active motion which the patient should be encouraged to perform. The purpose of physiotherapy is to relieve the muscle spasm which arises from the initiation of exercise. What it cannot do is replace active purposeful motions carried out by the patient.

It is perhaps to relieve the muscle spasm which arises from the initiation of exercise. What it cannot do is replace active purposeful motions carried out by the patient.

This latter principle seems sufficiently logical so that its application should present no difficulties with the average intelligent patient. In practice exactly the opposite situation is frequently encountered. As long as the various soothing physiotherapeutic procedures are administered some patients will disregard advice concerning the regular performance of active exercise. Perhaps it is the drudgery of the prescribed activity, or the fear of pain, or of causing a recurrence of the fracture or dislocation which accounts for the difficulty in impressing patients with the fact that the job of regaining function can be done only by themselves. Another explanation is the patient's concentration on the motion itself which prevents its successful accomplishment. The desire for regained activity cannot overcome the various inhibitions arising subconsciously from the train of events associated with the injury. It was discovered long since in dealing with mental patients and children that success in any therapeutic activity is greater when that activity can be transformed into some purposeful occupation or game. In this way the patient acquires an objective point of view and concentrates upon the end to be gained rather than upon the means employed. It was the realization of the effectiveness of this latter principle which gave birth to the use of occupational therapy in the treatment of fractures.

THE VALUE OF OCCUPATIONAL THERAPY

Dr H. A. Pattison's² definition of occupational therapy as "any activity mental or physical, definitely prescribed and guided for the distinct purpose of contributing to and hastening recovery from disease or injury" brings out the major factors involved in this form of treatment. Let us consider briefly how such therapy may benefit the patient suffering from a fracture or dislocation.

The average patient afflicted with a fracture has been leading a normal active life up to the time of his accident. As a result of his injury he is suddenly confronted with the prospect not only of temporary disability of the affected limb, but also of cessation of his ordinary occupations and habits of life. Frequently he will have to adjust himself to a prolonged period of hospitalization. As the head of a family he may have cause for worry about financial matters. All of these factors will

combine to lower the morale of the most stoical patient and cause him to brood over his misfortunes. By injecting some form of purposeful employment into the life of such a patient diversion from a morbid state of mind may be accomplished and a tendency to minimize the injury may be developed. Such cases afford an opportunity for the institution of occupational therapy directed toward the treatment of the mental complications of fracture patients. Supplying suitable reading matter, games, needlework, or other simple handicrafts to a patient confined to bed will often focus the patient's interest on these trivial activities and thus prevent the discontentment which so often accompanies unplanned leisure time.

After the period of immobilization of fractures in both ambulatory and bed patients has passed the chief concern is the restoration of function to the injured part. In order to attain this objective it is essential to institute active motions. Before undertaking any activity in a fractured limb the patient must regain confidence in the recovery of the limb in question. Many patients are able to perform any given program of exercises upon the reassurance of the physician that there is no risk in the gradual resumption of activity. By far the majority, however, will cooperate reluctantly at first and thereby prolong unduly their disability time. Finally there is a certain group of patients who are unable to overcome their fear of recurrent injury sufficiently to carry out the simplest motions voluntarily. Occupational therapy is of inestimable aid in rehabilitating patients in the latter two groups.

Carefully planned activities such as weaving, basketry, block printing, treadle sawing or light carpentry will almost invariably overcome the inhibitions of these fearful patients.

unconsciously

The patience frequently required in arranging all the details of the work for each case is more than compensated for

may be overcome more easily by the introduction of games

which demand activity of the affected limbs. After some initial hesitation a child is carried away by the spirit of play or competition. When the barrier of fear has been removed the problem soon evolves into a struggle to prevent overactivity.

Aside from initiating motion in a limb the site of a successfully healed fracture occupational therapy is also helpful in restoring the strength of the affected muscles to its original status. Gradually increasing the difficulty and intricacy of the task by using heavier and more complicated tools and adding weights to levers etc. will accomplish this end. Moreover by assigning the patient tasks in the occupational therapy workshop which are similar to or identical with those which he performs in his normal occupation a great service may be done. Too frequently disability time is prolonged because of the difficulty in bridging the gap between the successful accomplishment of all practical activities in the workshop or at home and the return to the employment carried out before the accident. This complication is avoided by demonstrating to patients or preferably by allowing them to demonstrate to themselves that they can wield hammers use saws and screw drivers operate lathes or wring clothes without endangering their recently healed bones or joints. Thus many cases of unconscious malingering will be prevented.

PREScribing OCCUPATIONAL THERAPY

Occupational therapy should never be used except upon the prescription of a physician. Most doctors recognize the indications for occupational therapy and know its value. Unfortunately however the majority are no more familiar with the numerous details involved in this form of treatment than they are with the many other therapeutic and nursing procedures which they are accustomed to prescribe. Therefore it is wiser for the average physician to refer his patients to a trained occupational therapist. The reasons for the need of occupational therapy and what results are expected should be indicated. Information concerning the general physical condition of the patient and cautions regarding any pertinent idiosyncrasies either physical or mental must always be included in such instructions. The judgment of the worker trained in this form of therapy should be respected in the choice

of the specific methods to be used. By such cooperation between the physician and the occupational therapist the administration of occupational therapy may be properly supervised and coordinated with the surgical treatment.

The restoration of function to a limb stiffened by disease cannot be undertaken without a thorough familiarity with the anatomy and physiology of the bones, muscles and nerves of that limb. Furthermore, the exact nature of the pathologic process must be understood and the treatment carefully directed to correct the specific disabilities at hand. The problem may be simply one of regaining the tone of atrophic muscles or perhaps of releasing muscle spasm which hinders activity of the limb and coordination of motion. On the other hand one may have to combat paralysis due to nerve injuries or to restore mobility of joints partially ankylosed by adhesions. There are often combinations of several of these factors which cause complications such as those illustrated by one of the cases cited below.

Fundamentally the success of occupational therapy depends, as noted above upon the abolition of inhibitions and the coordination of movement brought about by directing the patient's attention to the results of his activities while minimizing the importance of the methods of performing them. It may be well to reemphasize the fact that the greatest value of occupational therapy lies in its insistence on purposeful active motion. In prescribing these activities however, one must adhere to several basic principles. The activity must always be so regulated that there is no chance of its exceeding the limits of pain. A patient who undertakes his occupational therapy conscientiously and convinced of its efficacy, only to be stopped short by a sharp pain in the injured limb becomes thoroughly disillusioned and frequently cannot be persuaded to make another trial. Fatigue is second only to pain as an

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therapy were instituted. Exercises and work requiring the minimum expenditure of energy must be used at the start. Gradually the weight of tools and the resistance of machines are increased depending upon the progress made by the indi

vidual patient. In this matter fatigue is avoided and strength is gained. Occasionally the initial task undertaken by a patient is too strenuous. This point was well illustrated by a patient recently treated in our curative workshop.

A well built young mechanic with stiffness of the wrist and to a less extent of the elbow following a Colles fracture was advised to return to his work as the best means of regaining function of the disabled wrist. He soon revisited his physician stating that he was unable to carry out his job which consisted chiefly in hammering. He was therefore referred to the curative workshop where the cause of his disability was discovered to lie in the utilization of tools which were too heavy. By providing a light hammer for use in making small metal objects the patient was shown that his disability was simply due to undertaking too strenuous activity. After this demonstration he was able to apply the principle to his regular work and soon regained complete function.

The fatigue factor must also be given careful consideration in handling bed patients. The mere fact of confinement to bed seems to induce a feeling of lethargy and general weakness. Any work program therefore should not be forced too strenuously because the concentration demanded by even the simplest tasks necessitates an abnormal expenditure of effort by such patients. Consequently their activity must be carefully prescribed and should never continue to the point at which signs of fatigue are evident.

In cases in which an individual may be handicapped by the prolonged disability of a limb due to a serious fracture occupational therapy may be of great assistance. An organized program of reeducation of deformed or disabled limbs will help to develop to the fullest extent the potentialities for usefulness of such limbs. Exercises which strengthen the muscles of a well leg may facilitate the use of braces and splints on the injured leg. Weak individuals who are forced to use crutches because of an injured lower extremity may be aided by types of occupational therapy directed toward the development of muscles of the arms and shoulders. Without such exercises, and instructions in the proper use of crutches patients often develop secondary disabilities which become more distressing than the original injury.

METHOD OF EMPLOYING OCCUPATIONAL THERAPY

Before planning the program of work for any given case referred for treatment the occupational therapist must first consider whether the patient is confined to bed, or to a hospital ward, or is capable of visiting a workshop. This statement implies the availability of the rather elaborate equipment which is essential to the ideal exhibition of occupational therapy.

The apparatus required for bed patients is not elaborate and should never be cumbersome. Weaving on large frames, or crafts necessitating the use of multiple small parts which

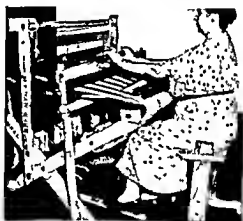


Fig. 476—The loom affords exercise for forearm, elbow, and shoulder disabilities as well as for those of the hip and knee.

might be easily misplaced in bed or of paints and dyes which might soil the bedclothes are examples of activities which should be avoided. Patients easily become discouraged by the difficulties inherent in manipulating such apparatus in a bed and soon lose interest in the work. Light tasks which can be performed with compact equipment are much more suitable. Sewing, knitting, cutting paper patterns, cord knotting and other similar occupations should be selected for patients confined to bed.

When the patient is ambulatory a much greater variety of occupations may be afforded by having him visit the occupa-

tional therapy workshop. Certain pieces of apparatus such as the loom, the treadle or bicycle saw and various mechanics' tools have come to be regarded as standard equipment for such workshops. The loom affords excellent opportunity for re-establishing wrist and finger motions in the manipulation of the shuttle, elbow and shoulder motion in applying the beater and hip, knee and ankle motions in using the treadles. Furthermore, by adding weights to these various levers the difficulty of the work may be increased as the patient's strength is aug-



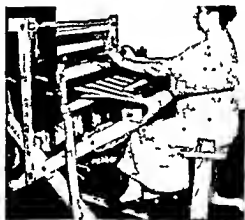
Fig. 477.—The bicycle saw is useful in restoring mobility and strength to disabled lower extremities.

mented. The bicycle saw is unequalled as a means of regaining mobility and strength in disabilities of the lower extremities. By adjusting the lengths and lateral positions of the pedals and the height of the seat, various degrees of mobility and strength may be accommodated. Both of these machines utilize to the fullest extent the principle of diverting the patient's attention from the beneficial exercise itself to the relatively unimportant end product. In addition, there is the added mental stimulus to excel in the quality of the articles manufactured. While

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these machines provide exceptional opportunities for muscle training, the fact that they are not available does not preclude



Fig 480 — Block printing requires motion of wrist. Rolling down incline produces flexion.

the development of an efficient occupational therapy workshop. The common tools such as the hand plane, screw driver, hammer, wrench and saw can be utilized just as efficiently in



Fig 481 — The same patient as Fig 480 showing the extension of the wrist in rolling up the incline.

accomplishing the desired results in disabilities of the upper extremities. For limbering and strengthening disabled wrists and hands, metal polishing, sand papering, painting and block



Fig 478—Wood planing is a simple but effective exercise for rehabilitation of the upper extremity



Fig 479—Mobilization and strengthening of the elbow and shoulder are readily accomplished with the common saw

Case I—J S, a forty-year-old civil engineer, was injured in an automobile accident on December 23, 1933. He suffered a dislocation of the right shoulder in addition to a fracture of the surgical neck of the humerus. Radial nerve injury was indicated by wristdrop. On January 6, 1934, the head of the humerus was removed at operation and the joint was reconstructed. After convalescence the patient was referred to the curative workshop of the Philadelphia School of Occupational Therapy on February 26, 1934. At this time his condition was as follows: shoulder, flexion to 160 degrees, abduction none, elbow, flexion to 80 degrees, extension to 140 degrees, range 60 degrees (normal 140 degrees), forearm, pronated, no active supination, wrist, flexion to 135 degrees, hyperextension none, fingers, flexion one third normal, could not approximate thumb and fingertips.

Patient was wearing a cock up splint on his wrist. He was anxious about his arm and complained of severe pain on attempting to use the arm. He was definitely neurotic but cooperative.

Occupational therapy was begun on February 26. Wood working and weaving were prescribed for full arm motions, and block printing and basketry for finer wrist and finger motions. Treatments were carried out three days weekly for twenty three weeks.

The final motions attained were: shoulder, flexion to 45 degrees, elbow, flexion to 45 degrees, extension to 180 degrees, forearm, pronation and supination normal, wrist flexion to 100 degrees, hyperextension to 260 degrees, fingers, normal.

On October 24, 1934, the patient returned to his regular employment and used his arm normally. There was slight limitation of the range of shoulder motion, the elbow motion was normal, the wrist was weak in hyperextension, finger motion was normal except for slight flexion contracture of the fifth finger.

Case II—B A, a forty year old machine operator, caught his left hand in a rod rolling machine on December 19, 1933. He suffered a severe strain of the left shoulder and lacerations and multiple fractures of the metacarpal bones of the left hand.

At operation the first and fifth fingers were amputated.

printing are ideal exercises. Variations in the position of the object and in the hardness of wood and metal should be graded to obtain the proper degrees of motion and resistance demanded by each individual patient.

If facilities for a specially organized shop are not available for occupational therapy its principles may be carried out almost as effectively by employing more homely, but perhaps also more practical activities. Sweeping, dusting, bed making, washing dishes and clothing, gathering and sawing firewood and mowing grass can be readily transformed into a satisfactory means for muscle training by one versed in the fundamen-



Fig. 432—Sand papering wooden object promotes use of wrist and fingers

tals of occupational therapy. A peculiar advantage of this latter type of activity is that it rehabilitates the patient for the resumption of the ordinary tasks of housekeeping or manual labor. Having established the patient's ability to master a program of menial tasks while in a hospital, he may then be discharged to carry on his activities at home. Progress may be noted and alterations in activities planned at intervals of five to seven days in visits to an out patient department.

The following cases are included as concrete evidence of the efficacy of occupational therapy in the rehabilitation of patients suffering from disabilities resulting from fractures and dislocations.

his feet. An x ray examination revealed a comminuted fracture of the left acetabulum with displacement of one fragment into the pelvis. There was also a fracture of the body of the pubis on the left.

Treatment consisted in extension of the left leg in the Russell apparatus together with suspension of the pelvis in a sling. Passive and active exercises were instituted. From October 3 to November 12 the patient was under the care of an occupational therapist for diversional activities.

On November 12 the patient was discharged from the hospital and referred to the curative workshop. He was walking with the aid of crutches and had a marked weakness of the knee extensors.

Occupational therapy consisted in sawing wood on the bicycle saw requiring hip, knee and ankle motions. At the start he was unable to complete a full revolution of the wheel and simply pushed the pedal backward and forward through a small arc. Gradually both range of motion and strength increased. Treatments lasting one and one half hours at the start, and increasing to three hours were carried out on three mornings each week. There were 43 treatments.

On March 29, 1935 the man returned to work climbing ladders and scaffolding without difficulty.

SUMMARY

The advantages of the principle of rapid rehabilitation of patients disabled by fractures and dislocations have been recognized for many years. Physical therapy together with prescribed voluntary exercises was the first form of treatment employed to attain restoration of function in disabled limbs. More recently the improved results obtained by the use of purposeful active motions which is the fundamental principle of occupational therapy have led to the extensive development of that form of treatment. Because of its proved superiority over other methods we feel that physicians should become acquainted with the benefits to be derived from rehabilitation therapy and learn to prescribe it intelligently. The actual administration of such therapy is carried out most successfully by specially trained occupational therapists. With the growth of occupational therapy certain devices and machines which

Physiotherapy was prescribed for both the shoulder and hand. There was no improvement in hand motion.

On June 2, 1933, the patient was referred to the occupational therapy curative workshop for reeducation of the left hand. Condition on admission: wrist flexion to 120 degrees, hyperextension to 195 degrees, range 75 degrees (normal 145 degrees), fingers, flexion limited by one third, arm, weak, shoulder stiff. Patient was depressed and doubtful as to future employability.

Occupational therapy treatment consisted of woodworking for general use and strengthening of the hand, and braid weaving for finer finger movements. The patient received 35 treatments, 3 each week. He attained his maximum improvement on September 2, 1933, when he returned to his former employment. The strength of both hand and arm was greatly improved and he was able to grasp with his injured hand. His general morale was excellent.

The ranges of motion attained in this case were: wrist limitation of 25 degrees of normal range; fingers, motion three fourths normal.

Case III—C S, a fifty one year old female power machine operator, was referred to the curative workshop on June 22, 1933, for restoration of function of the middle and distal phalangeal joints. She had been disabled following a fracture of the left wrist on September 2, 1931, and had failed to improve on a course of extensive physiotherapy.

On admission her condition was as follows: wrist, flexion to 130 degrees, hyperextension to 230 degrees (normal); fingers, metacarpophalangeal joints one third normal motion.

Occupational therapy consisting of block printing and braid weaving, using the fingers and no shuttle, was instituted on June 22. Treatments were carried out three times weekly for eleven weeks. At the end of that time the strength of both hand and wrist had improved markedly and the use of the finer finger motions had been regained. Wrist flexion was normal. The patient was discharged on September 12, 1933, to return to her former occupation.

Case IV—L R, a forty five year old house painter, fell 2 stories from a scaffold on September 18, 1934. He landed on

CLINIC OF DR W WAYNE BABCOCK

TEMPLE UNIVERSITY HOSPITAL

REGIONAL ILEITIS

Regional ileitis, distal ileitis, terminal ileitis, nonspecific granuloma of the intestine was separated as a pathologic clinical entity by Crohn, Ginzberg and Oppenheimer in 1932¹. It is a granulomatous disease generally considered to be of unknown cause, involving chiefly the lymphoid tissue of the mesentery and the submucosa of the terminal ileum. Much less frequently the disease affects other portions of the intestine, particularly the jejunum. Usually it is sharply limited to the lower ileum and does not invade the cecum or colon. In the early stage the bowel is swollen, heavy, congested and thickened. Commonly the appendix shows either a chronic or acute inflammation especially of the serosa apparently from contiguity. The affected portion of bowel is enlarged, has a beefy red surface, a thick rubbery soggy edematous wall, which has been compared to a section of garden hose, a long narrow lumen at first rather uniform, but in chronic forms usually irregular and distorted. Early the lumen is narrowed by the exudative and hyperplastic changes in the wall, later by the secondary fibrostenotic process and at times by papillary or polypoid projections from the mucous surface which with necrosis and ulceration may produce irregularity on the roentgen film. In chronic cases, particularly, two or more areas separated by sections of normal bowel may be found. In 39 cases reported by Pemberton and Brown,² the ileum was involved in 34 cases, the upper ileum in 4, the jejunum in 3 cases, while multiple lesions were found throughout the small intestine.

¹ *Jour Amer Med Assoc* 99 1325-1328 (Oct 15) 1932

² *Annals of Surgery* 105 355 (May) 1937

are especially adapted to restore the desired motions, have been evolved. However, the lack of such equipment does not preclude the effective employment of occupational therapy, since excellent results may be obtained by the utilization of common mechanics' tools and the performance of menial household tasks. The great contributions of occupational therapy to the treatment of fractures are (1) its beneficial effect on the morale of the patient, and (2) its rapid restoration of function to disabled limbs. Both factors depend upon the use of purposeful active motions while emphasizing the relatively unimportant ends to be attained and minimizing the means employed.

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The lesions differ from those of tuberculosis in the smooth or shaggy, deep red peritoneal surface of the affected segment of bowel without definite tubercle formation, the great thickening, largely from the diffuse, rather uniform granulomatous hyperplasia in the submucosa, tapering above to normal bowel the absence of the ragged transverse ulcers and tubercles along the blood vessels, the extent and more uniform narrowing of the intestinal lumen, the absence of gross caseation or of tubercles upon the adjacent peritoneal surfaces or in the omentum or mesentery the absence of associated lesions in the lungs pelvic organs and appendix and the failure to find the mycobacterium of tuberculosis in the stained sections or by animal inoculation

Symptoms—Clinically the disease has been divided into a stage of ulcerative enteritis, a stage of obstruction, and a stage of fistulous formation. This sequence, however, is not invariable. Abdominal pain usually referred to the lower abdomen, diarrhea, at times with the passage of bloody stools nausea, vomiting, moderate abdominal distention and nervous irritability are common symptoms. Marked tenesmus is rare. There usually is progressive weakness anemia anorexia, loss of weight periods with moderate fever (99° to 103° F) and very often chills but with a leukocytosis of only 10 000 or less. From 2 to 4 or more liquid to semi-solid stools may be passed daily. Stenosis leads to constipation abdominal cramps and visible peristalsis and occasional vomiting. Complete obstruction marked general abdominal distention and tympany are rare.

On physical examination the rounded or nodular mass about a fistulous tract or the thick tender segment of bowel, resembling a section of garden hose may be felt in the lower right abdominal quadrant or elsewhere. The mass from an ileosigmoid fistula usually occupies the lower left quadrant the mass from the less common ileocolic fistula may be located in the upper right or left abdominal quadrant. Commonly the condition is first diagnosed as appendicitis but after the removal of the appendix as has occurred in over 40 per cent of the cases the symptoms continue and fistulous tracts develop.

The roentgen examination shows early a narrowing of the lumen of the affected portion of bowel and flattening of the

in 2 cases. There is a marked tendency to a perforative type of ulceration which leads to the formation of internal and external abscesses and fistulous tracts containing a whitish yellow pus. The fistulas may connect with a loop of adjacent ileum, the sigmoid, transverse colon, appendix, or any other hollow intra abdominal viscus. The peritoneal surface is commonly roughened or shaggy from plastic exudate. The affected area of bowel may be adherent but not infrequently are free from adhesions.

The lymph nodes of the greatly thickened adjacent mesentery are markedly and symmetrically enlarged, reddish gray, smooth, elastic, rather firm, but not hard. As the process continues, an adhesive peritonitis may develop often with extensive dense adhesions. A small amount of free turbid peritoneal fluid is found in many cases. At times, as in Case III, the inguinal lymphatic glands may also become enlarged and through invasion by the colon bacillus or other micro-organisms, fuse, suppurate and form abscesses which discharge through the skin.

Etiology—No specific organismal cause has been proved by cultural methods or by animal inoculation. Homans doubts that the disease is a clinical entity. Chiefly from the agglutinating properties of the blood serum, the *Bacillus dysenteriae* is claimed as the causal agent by Felsen¹. A number of observers have found streptococci in the lesions, but for the most part the condition has been accepted as a definite and previously unrecognized disease of unknown cause.

Regional ileitis occurs more frequently in males in those between fifteen and forty years of age and in the Jewish race. Microscopic sections show an intense granulomatous process and often the formation of giant cells containing multiple nuclei arranged peripherally, but with little or no gross caseation.

Early the tissues, especially the submucosa and to a lesser

HISTOLOGY

tissue interspersed with granulation tissue which may contain giant cells and collections of leukocytes.

¹Ann. Int. Med. 10: 645-669 (Nov.) 1936.

ing to a fatal issue. It is possible that a number of the early, less advanced and unrecognized cases have recovered spontaneously, after appendectomy or under medical treatment, but those that have advanced to the stage of accurate diagnosis have apparently rarely recovered without operative elimination or excision of the diseased segment of bowel. The average duration is four years, but the condition may continue as long as twenty years. Improvement not infrequently follows an ileotransversostomy, but the tendency for the progression of the disease after the procedure proves the desirability in most cases of removing all diseased portions of the bowel at a second operation. Recovery usually follows the complete removal of the diseased segment of bowel, but the occasional recurrences reported after enterectomy indicate either that all diseased bowel was not removed or, what is more likely, that the disease has some tendency to relapse.

Treatment—During the acute stage of the disease no attempt should be made to liberate or remove the diseased portion of bowel. The patient should be given a readily assimilable, nonirritating, high vitamin and high caloric diet. Bismuth subiodide given in 5 grain capsules every two to four hours is useful in controlling the tendency to diarrhea. Abscesses should early be drained. Ileostomy leads to a heavy loss of liquid and of food and is not advised. The choice of operation after the acute symptoms have subsided is a primary ileotransversostomy, the ileum being divided well above the lesion and the proximal end united to the side of the transverse colon, the distal end being closed or exteriorized. Marked improvement usually follows this operation and the diseased bowel may be removed weeks or months later at a time when the patient has sufficiently improved to withstand the more serious operation and when the peritoneum has acquired increased resistance to infection. However, with the extensive matting of bowel as in Case I and in Case II there may be difficulty in locating the segment of ileum just above the lesion and there is the danger of eliminating an excessive length of small intestine. The short circuiting of a considerable length of small intestine may lead to serious toxemia, grave anemia, or a syndrome similar to beriberi. A deficiency syndrome with the blood picture of primary anemia occurred in 3 of Pemberton and Brown's

normal high mucosal relief pattern. The thin line of barium through the affected area has been termed the *string sign* by Kantor. In the later stages from ulceration or mucosal thickening, the relief pattern may become irregular and jagged. Weber has called attention to relative hypermotility of the affected, as contrasted with the hypomotility of adjacent unaffected bowel.

Diagnosis—During the course of regional ileitis 4 types of symptoms may be encountered:

1 *Appendicitis type* is characterized by generalized abdominal colic, pain tenderness, and the formation of a mass usually in the right lower abdominal quadrant. The mass consists of thickened, inflamed bowel and omentum which in many cases finally encases an abscess or fistula. The course is usually slower than that of a septic appendix; the fever and leukocytosis less intense. However, considering the variation in the onset and intensity of symptoms from appendicitis it is not surprising that about one half of the patients have the appendix removed or the abscess drained before the correct diagnosis is made.

2 *Ulcerative enteritis type* is marked by colicky lower abdominal or periumbilical pain with several loose movements daily that may contain mucus, pus, and traces of occult or visible blood. The diarrhea may continue for months with slight evening fever, progressive weakness and anemia until and even after the development of fistula or partial stenosis.

3 *Fistulous type* is the common sequence occurring after or without a preceding appendectomy. The persistence and often multiplicity of the fistulas, their resistance to simple surgical measures, and the absence of tubercles in the granulations or of a preceding pulmonary lesion differentiate them from simple postappendectomy or tuberculous fistulas.

4 *Stenotic type* is associated with dull colicky pain, distention usually of the lower abdomen, relieved by defecation, borborygmi, visible peristalsis and constipation. Vomiting is rarely frequent or stercoraceous and usually follows the taking of food. Tympany likewise is rarely of marked degree.

Prognosis—The prognosis of a well developed case of regional ileitis is that of a progressive or recurrent disease with fistula formation and without operation often slowing progress.

ing to a fatal issue. It is possible that a number of the early less advanced and unrecognized cases have recovered spontaneously, after appendectomy or under medical treatment, but those that have advanced to the stage of accurate diagnosis have apparently rarely recovered without operative elimination or excision of the diseased segment of bowel. The average duration is four years but the condition may continue as long as twenty years. Improvement not infrequently follows an ileotransversostomy but the tendency for the progression of the disease after the procedure proves the desirability in most cases of removing all diseased portions of the bowel at a secondary operation. Recovery usually follows the complete removal of the diseased segment of bowel but the occasional recurrences reported after enterectomy indicate either that all diseased bowel was not removed or what is more likely that the disease has some tendency to relapse.

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lieved by a normal diet with added vitamin B. In practically all advanced cases blood transfusions, infusions of glucose solution and as varied a diet as the patient can assimilate should be used together with the administration of liver extract and of vitamins especially vitamin B. Evidence of calcium loss following colectomy or colonic exclusion and ileostomy presented by Whittaker and Bergen¹ suggests also the desirability of intravenous injections of calcium in certain cases. Finally it is very important that operation be not delayed until the patient falls into the advanced cachexia found in 2 of the following cases.

Case I. Regional Ileitis with Abscesses and Fistulas Two Previous Operations with Diagnosis of "Appendicitis" and "Postoperative Adhesions" Resection of 105 cm. of Intestine.—Mr. A. Jewish grocer married age forty was admitted to the Temple University Hospital March 25, 1935 with a history of having been operated upon three years before for perforative appendicitis. The wound continued to drain for six or seven months after the operation and when it closed pain developed in the lower abdomen. Two years before admission (1933) a second operation had been performed with the liberation of intestinal adhesions. Since that time fecal

There was a vertical
surrounded by small
yellowish green pu-
ere hard and dense
infiltrated and there was an underlying large area of resistance suggesting an advanced infiltrating carcinoma. The preoperative diagnosis was neoplastic or inflammatory intra abdominal mass.

On March 29, 1935 under spinal anesthesia induced by injecting a mixture of 10 mg. of pontocain and 100 mg. of procaine through the first lumbar interspace a large section of the infiltrated right abdominal wall including an area of

¹Surg. Gynec. and Obst. May 1935

skin and underlying muscle measuring 21 cm long by 8 cm wide was excised. The deep layers of the abdominal wall were very hard and fibrous and had a grayish translucent appearance. The intestinal coils on the right side of the abdomen were densely adherent and fused with fatty omentum and thickened mesentery interspersed with numerous areas of supuration. The wall of the ileum was greatly thickened but the mucosa was nearly normal in appearance. About 105 cm of intestine were resected including 60 cm of terminal ileum and about 45 cm of colon. An end to end anastomosis was made between the end of the ileum and the distal end of the transverse colon the end of the ileum being divided obliquely to adapt it to the larger lumen of the colon. Two internal rows of continuous fine silk reinforced by the interrupted sutures of No 35 alloy steel wire were used for the anastomosis. The abdominal wall was closed with through and through sutures of alloy steel wire with continuous No 35 wire for the skin. One cigaret drain was inserted below the line of anastomosis.

The patient made a satisfactory convalescence and was discharged from the hospital in good condition twenty seven days after the operation. Superficial sinuses continued to discharge from the wound for a number of months were filled with 50 per cent bismuth subiodide paste and finally closed. The patient reentered the hospital in August 1935 with an acute perirectal abscess which was drained. Following this there was a residual fistula *in ano* which was excised after readmission November 5 1935. On April 15 1937 the patient was found to be in good condition was at work and had gained about 40 pounds in weight. From 1 to 3 bowel movements usually rather soft or liquid occurred daily.

Pathologic studies made by Dr Soloff and Dr Lennon showed masses of fibroplastic tissue and focal collections of leukocytes huge primary lymph follicles separated by more or less abundant fibrous connective tissue containing occasional multinucleated giant cells. The lymphoid hyperplasia was tremendous. No fungi were found and actinomycosis was excluded. The large areas of granulation tissue were infiltrated by numerous round cells large plasma cells polymorphonuclear leukocytes and occasional multinucleated giant cells. Inoculation of portions of the tissue in a guinea pig failed to produce the lesions of tuberculosis.

Case II Regional Ileitis with Multiple Lesions First Treated as Suppurative Appendicitis Resection of 234 cm of Intestine—Sydney P., Jewish student aged nineteen was admitted to Temple University Hospital April 21 1936 with a history of always having been underweight and of poor appetite. His bowel movements were said to have been normal until the present illness. In August, 1935, an acute generalized griping abdominal pain with nausea anorexia but without vomiting developed. The pain increased in severity localized in the lower right abdominal quadrant but later became less intense and recurred intermittently. The bowels did not move from the time of onset of the pain until he took a physic four days later. A physician was not consulted until he had been ill seven days. Then under the diagnosis of appendicitis an abscess the size of an orange was drained the drainage continuing for about two months. November 5 1936 another mass was found in the abdomen which was opened through a lower median incision. Since the first operation the patient has had 2 or 3 attacks of diarrhea lasting two or three days but no blood has been noticed in the stools. Since the second operation there has been a daily rise in the evening temperature without chills or sweat. The appetite is poor. There has been no cough. His highest weight which was in the summer of 1935 was 126 pounds. The lower abdomen is distended and the wall infiltrated and tender. There are two abdominal scars one over McBurney's point the other in the midline below the umbilicus. Since the second operation there has been constant discharge of fecal material mixed with bubbles of gas through 3 fistulous tracts 2 in the second median scar incision and 1 in the McBurney scar.

The patient was emaciated weighed about 98 pounds and appeared to be acutely ill. His temperature was 102.3° F.

face was drawn
 circles the eye
 and of a bluish
 color. No abnormal signs were found over the heart and lungs and the abdomen was scaphoid. The lower right rectus scar 10 cm long was healed except for 2 fistulous openings near the upper end. The oblique McBurney scar about 6 cm long had a fistula in its middle third. Injections of a methylene

blue solution showed communications between the fistulous tracts. Following the injections the patient vomited bluish material and had several liquid bluish stools. The hemoglobin was 10.5 Gm. to each 100 cc. (61.9 per cent) of blood; erythrocytes 4,880,000; leukocytes 6250 with 9 per cent monocytes and 1 per cent eosinophils and 43 per cent filamentous and 30 per cent nonfilamentous forms were found. The preoperative diagnosis was regional ileitis.

At operation on April 23, 1936, under spinal anesthesia with 170 mg. of procaine, the sinuses were sterilized by lightly swabbing with zinc chloride solution and delineated by injecting an ethereal solution of methylene blue. An L-shaped incision consisting of 2 elliptical portions encircling the 2 old scars was made. In order to remove all of the foci of the disease, 234 cm. of very adherent friable ileum, cecum and ascending colon were finally freed and delivered through the upper end of the incision and excised. Glass tubes were tied in the terminal ends, gauze drains inserted to the pelvis and the rest of the wound closed with interrupted wire sutures. The mesenteric lymph nodes of the lower ileum and cecum were enlarged to a diameter of about $3\frac{1}{2}$ cm. with adherent dense infiltrated and thickened mesentery and greenish yellow degenerated friable tissue. Upon section the walls of the terminal ileum were found to be thickened to a diameter of $\frac{1}{2}$ to 1 cm. The lumen was narrowed and partly obliterated, the mucosa ragged, thick and red. This process extended about 20 cm. above the cecum, above which there was a gradual thinning of the coats as the bowel approached normal. About 150 cm. above the ileocecal valve there was a fistulous opening communicating with the vertical wound associated with a moderate thickening of the wall of the bowel. About 30 cm. above this area was a raised papillary plaque on the mucosa of bluish gray color, 6 cm. long by 3 cm. wide. A similar plaque was seen 10 cm. nearer the jejunum. An additional 40 cm. of more normal appearing ileum was found to be so frayed and damaged after freeing it from adhesions that it also was removed. While the cecum was thickened and infiltrated, the pathologic change was slight in comparison to that of the ileum. The cecum contained 2 fistulous openings communicating with each of the old incisions. Four days after the operation the protruding end

of ileum was united to that of the colon with interrupted fine alloy steel wire sutures. The first week after the operation the fever largely subsided. The bowel was very friable and the line of suture reopened and additional sutures were inserted on May 14 and May 25, and suppurating pockets drained. Blood transfusions, intravenous infusions of glucose, vitamins and a varied diet were used during the course of treatment. On May 25, about four hours after the last operation, which was done under local anesthesia and required forty five minutes the patient suddenly complained of numbness in the left foot became pulseless, and expired apparently of thrombosis. This was thirty two days after the enterectomy.

Pathologic studies of the surgical specimen made by Dr H C Lennon revealed greatly thickened and in some areas edematous intestinal mucosa, richly infiltrated with polymorphonuclear and small round cells. The muscular wall was infiltrated in some areas by small round cells. Sections of various portions of the intestine show virtually the same picture with variations in the degree of ulceration. Guinea pig inoculation of the removed tissue was not followed by tuberculosis.

Case III Regional Ileitis with Suppurative Inguinal Lymphadenitis—Miss Doris B. aged twenty seven, a frail Jewish stenographer, was first seen June 15 1936. She had never been very strong and eight years before had become weak and lost 20 pounds in weight. Since an emotional shock about four years before during which time her weight dropped from 135 to 94 pounds she had been highly nervous, apprehensive and worried. Two years before there had been an

stools and had vomited once or twice daily. A tender firm mass could be felt in the right lower abdominal quadrant for which operation was advised but the patient continued at home under treatment until January 21 1937 when she was admitted to Temple University Hospital with an acute suppurative right

inguinal lymphadenitis. Before admission to the hospital the patient had been confined to bed for seven days with pain and swelling in the inguinal region. Her last menstrual period was ten months before and lasted but one day. On January 22, 1937, a 6 cm. transverse incision was made over McBurney's point to an intraperitoneal abscess containing necrotic tissue and thick grayish pus walled off by adherent great omentum. Purulent collections were also opened in the layers of the abdominal wall and in the fused right inguinal lymph nodes. The operation was done under spinal anesthesia with the injection of 150 mg. of procaine. Shortly after her return from the operating room, the pulse became imperceptible, the volume returning after the intravenous injection of 500 cc. of 10 per cent glucose solution. Five days after the operation the temperature fell to normal and the pulse to about 100. February 18, or twenty seven days after the operation, the old incision was enlarged and additional lateral lymphatic areas opened and curetted with the removal of the broken down suppurating transverse chain of inguinal lymph nodes. These were surrounded by indurated inflammatory tissue. Microscopically this tissue resembled a chronic form of granulation tissue with many polymorphonuclear leukocytes and giant cells together with areas of solid epithelioid cells as well as of fibrous connective tissue. The patient was discharged from the hospital apparently improved on March 5, 1937. Intestinal contents soon began to escape from the wound, the patient lost appetite, complained of daily distress and a tendency to diarrhea and a deep lying elastic cylindrical elongated mass became more palpable in the lower right abdominal quadrant of the abdomen which was believed to be the diseased terminal ileum.

She was readmitted to the hospital April 15, 1937, with a pulse of 120, a temperature of 99.2° F., 72 per cent hemoglobin, 5,000 erythrocytes, 6,000 leukocytes, 470 polymorphonuclear neutrophils, 43 being lymphocytes, 10 per cent monocytes with 24 nonfilament and 23 filament forms. The abdominal fistula discharged freely. Methylene blue solution injected through the fistula colored the ensuing stools and urine. The temperature usually was either subnormal or slightly elevated. There were periods of marked mental depression and occasional vomiting. There was no characteristic

reaction from the injection of tuberculin. On May 1, 1937, under spinal anesthesia, with procaine and pontocain the abdomen was opened after injecting methylene blue into the fistula. A 14 cm. diagonal muscle splitting incision was made about the old scar, the ileocecal and mesentery vessels ligated and about 60 cm. of the distal ileum and 15 cm. of cecum and ascending colon exteriorized and removed, the ends being tied to a glass Y tube after closure of the rest of the wound. The

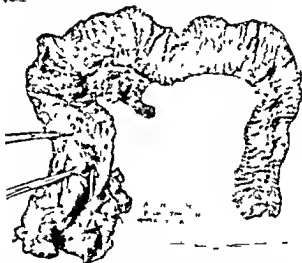


Fig. 483.—Regional ileitis. Case III showing the marked thickening of the wall and the narrowing of the lumen of the distal ileum—applicators have been passed through the ileo abdominal and ileo appendiceal fistulas.

terminal 30 cm. of ileum had a red injected serous surface walls about five times the average thickness, a lumen greatly narrowed and mucosa showing polypoid thickening without gross ulceration. The diseased ileum had two fistulas, one entering the thickened adherent appendix, the other passing through the abdominal wall at the site of the old incision. The mesentery was markedly thickened and contained lymph nodes 2 or 3 cm. in diameter, smooth, symmetrical without

evidence of caseation and with a grayish pink surface on section

For the most part the temperature continued normal or subnormal after the operation the pulse varying from 100 to 120 May 19, the spur was divided to a depth of about 5 cm and the edges united with interrupted sutures of No 35 alloy steel wire The external necrotic edges were trimmed and united with inverting fine wire sutures The adjacent wound had united without reaction As the bowel reopened on May 21, the spur was further divided about 3 cm the opening of the bowel closed with additional wire sutures the skin being brought partially over the sutured bowel As intestinal leakage from the incision recurred the exteriorized bowel was again trimmed and sutured extraperitoneally Nine hours later there was a severe attack of abdominal pain which was followed by vomiting some abdominal distention and weakness of pulse, which progressed to death from a seropurulent peritonitis June 3 Examination of the wound revealed no leakage or other source of the peritoneal infection From the number of giant cells found in the enlarged lymph nodes the pathologists making the examination first made a diagnosis of hyperplastic tuberculosis

Dr Lawrence W Smith reports The lesions of the lymph nodes are certainly very suggestive of tuberculosis showing rather characteristic focal accumulations of epithelioid cells and the presence of a goodly number of typical giant cells There is however no actual caseation and a slide stained for tubercle bacilli has not revealed their presence although this by no means excludes the diagnosis The slides from the ileum are less definitely suggestive of tuberculosis There is diffuse chronic inflammatory reaction in which varying types of mononuclear cells are found including chiefly lymphocytes and plasma cells with a moderate interspersing of large mononuclears No definite tubercles are seen and without the lymph node, I doubt if the question of tuberculosis would be raised Animal inoculation of the tissue was negative of tuberculosis

These 3 cases illustrate the progressive course of regional ileitis and the resemblance to suppurative appendicitis ulcerative enteritis tuberculosis actinomycosis or even malignant disease In these patients special diets, vitamins, vaccines, blood

transfusion, tuberculin, intestinal anti-septics, iodine, emetine gold salts intravenously, colonic injections and other measures produced no substantial results. In the first case a high degree of general peritoneal resistance to infection had apparently been acquired. In the third patient there was a lack of general and of local resistance. In the second and third cases the Mikulicz type of resection left fistulas very difficult to close despite the use of very fine rustless steel wire sutures. We

and steel. The results in these 3 cases teach the advantage in terminal ileitis, of eliminating the diseased segment by an end to side anastomosis between the ileum and transverse colon as a preliminary to the excision of the bowel.

Arterial Resection and End to end Arteriorrhaphy in the Treatment of Aneurysms of the Extremities—Aneurysms of the larger arteries have rarely been treated by excision with end to end suture of the artery. The operation where it can be performed has a number of advantages. The circulation in the distal portions of the limb is thus best maintained and the atrophy and weakness of the limb which in some degree invariably follows the ligation of its major artery does not occur. The danger of gangrene always to be feared from the ligation of the femoral, popliteal or lower third of the

is rare. We have resected the axillary, brachial and radial arteries with end to end suture for aneurysm the result of gunshot or incised wounds all with satisfactory results. In the following case the second aneurysm with an arteriovenous communication was overlooked at the first operation. At the second operation we would have preferred to resect more of the lower segment of the femoral artery to eliminate its lateral defect. This however, would have necessitated the extensive liberation of the artery into the popliteal space in order to

obtain sufficient slack to overcome the longer gap and would have unduly prolonged the operation. The addition of the small amount of pontocain to the spinal anesthetic solution was of great advantage in prolonging the anesthesia to over three hours.

Case IV Saccular Aneurysm of the Femoral Artery Aneurysmectomy, Overlooked Second Aneurysm with Arteriovenous Fistula Resection of the Affected Segment of the Femoral Artery with End to end Suture—Mr. M. aged thirty one married cabinet maker weight about 200 pounds in June 1936 was shot through the left thigh and the right shoulder. He remained in a hospital three months and was discharged healed but practically bedfast from weakness throbbing and marked discomfort in the thigh especially on standing or attempting to walk. He was admitted to Temple University Hospital October 20 1936 with scars from his

side

round

felt over the junction of the middle and lower thirds of the femoral artery accompanied by a harsh roaring systolic and diastolic bruit heard from the inguinal region to the lower third of the thigh. On October 22 1936 under spinal anesthesia a saccular aneurysm of the lower part of the middle third of the femoral artery about the size of a golf ball was exposed through a long oblique incision. The femoral artery was occluded by special clamps both above and below the sac guide sutures were placed in the upper and lower margins of the neck of the sac which was then cut through with removal of the aneurysm. The opening in the artery was closed with a continuous fine silk suture. The muscles and fascia were then united over the artery with interrupted silk sutures. The skin was closed with continuous No. 35 alloy steel wire without drainage. The relatively narrow neck of the aneurysm was on the mediolateral aspect of the femoral artery at about the junction of its middle and lower third. The single opening of the sac measured 1.5×0.8 cm. The lining of the sac was smooth and glistening the walls 2 to 3 cm in thickness the microscopic study disclosed no normal intima or internal elas-

tic lamina, and relatively little adventitia. The sac wall appeared to be made up of bundles of involuntary muscle" (Dr H C Lennon)

The wound healed primarily, the dorsalis pedis artery continued to pulsate, and the patient was discharged from the hospital five days after the operation. The patient improved and

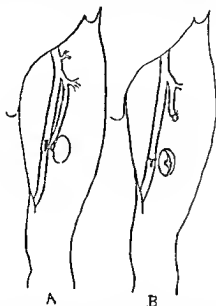


Fig 484—Case IV. At the first operation the sacular aneurysm of the femoral artery was excised and the opening in the artery closed by suture (A). At the second operation about 4 1/2 cm of the artery were excised with end to end suture, an arteriovenous fistula eliminated and the disconnected adherent aneurysmal sac plicated but not removed (B).

a
bruit and marked pulsation were transmitted through the
scar. The patient reentered the hospital May 25 1937. Under
spinal anesthesia with procaine 100 mg pontocain 4 mg and
with a soft elastic Esmarch bandage as a provisional tourniquet

the scar was excised and the artery was reexposed May 26 1937 With the separation of very dense adhesions a deep lying saccular aneurysmal sac about the size and shape of a small egg was discovered beneath the femoral artery about the junction of its middle and lower third The femoral artery was divided and cut free from the sac which was then opened and emptied of clots and obliterated by plicating the interior with layer sutures of interrupted fine silk

Apart from the opening measuring about 2×1 cm through the neck of the sac no other opening was found in the aneurysmal wall The very adherent profunda femoris was dissected free from the region of the aneurysm and ligated

for about 2 cm As the arterial ends could only be brought together with tension the lateral opening was first closed with a continuous fine silk suture An end to end arterial anastomosis was then made using 3 guide sutures and a continuous encircling suture of fine arterial silk On cutting away the tourniquet free leakage occurred from the junction where the lateral defect in the lower segment of the artery joined the line of circular closure This was arrested by additional fine silk sutures The muscular and aponeurotic layers were closed in turn by buried layer sutures without drainage The following morning pulsation in the left dorsalis pedis artery was well marked The swelling of the leg rapidly subsided the venous distention disappeared and the patient was discharged completely relieved twelve days after the operation

Congenital Atresia of the Esophagus with Tracheo-esophageal Fistula—In the common form of congenital atresia of the esophagus the gullet consists of two separate segments The upper segment passes from the hypopharynx to a blind end in the lower part of the neck The lower segment of the esophagus runs from an opening in the trachea at its bifurcation to the cardiac end of the stomach The upper end of the esophagus therefore is completely obstructed Food taken by mouth overflows into the larynx and enters the trachea and lungs from which it is expelled as a foamlike mixture of mucus food and air which fills the mouth and nose

In coughing or other expiratory movements, air and pulmonary secretions pass from the trachea through the lower segment of the esophagus into the stomach and duodenum which become distended. In vomiting the gastric contents are forced into the trachea and bronchial tree producing strangulation with cough and cyanosis. When therefore a newborn infant on attempting to nurse immediately coughs suffocates, and froths at the mouth, it is evident that the child has a congenital atresia of the esophagus. These symptoms in a newborn baby are diagnostic and no attempt should be made to probe the esophagus or especially to give a barium mixture for a roentgen study as the mineral may enter the lung and do great harm.

A variety of operations have been suggested for the condition none of which has thus far saved an infant's life. A simple gastrostomy for feeding is ineffective because it fails to prevent the distention of the stomach with air from the lungs or the regurgitation of gastric contents into the lung while the infant being unable to expectorate continues to have the secretions of the oral cavity and pharynx pass into the lungs. If an aspirating tube is passed through the nose into the pharynx to continuously aspirate secretions as shown by Wangenstein a bilateral otitis media follows. The eustachian tube in an infant has a horizontal course favoring infection of the middle ear. By repeatedly aspirating fluids directly from the mouth with other measures for feeding life has been prolonged up to two or three months. For the successful operative treatment for this fatal condition there should be provided (1) a permanent vent for the escape of food oropharyngeal and pulmonary secretions from the pharynx (2) the lower segment of the esophagus should either be disconnected from the trachea or should be given a permanent external vent. The former procedure involving a thoracotomy and mediastinotomy is too severe an operation for a newborn infant. The latter procedure may be rather easily accomplished by completely disconnecting the cardiac end of the stomach or adjacent esophagus and forming with it a permanent opening upon the surface of the skin. (3) a permanent gas-

of success. The operation consists of three procedures which may be done at the same time or on successive days.

1 The abdomen is opened through an upper vertical left rectus incision the cardiac end of the stomach pulled down then by gently pushing away restraining attachments the cardia and adjacent esophagus are brought as close to the skin as possible. The stomach is then divided as near the cardia as feasible the upper end inverted and closed around a drainage tube and securely anchored to the skin near the upper end of the abdominal incision. Failure to adequately anchor the cardiac stump together with the slipping of the holding ligature led to internal leakage and fatal peritonitis in the case to be reported.

2 The open end of the distal part of the stomach is carefully inverted and closed around a small rubber feeding tube and securely anchored to the abdominal wall. A gastrostomy stab incision to the side of the original opening may be used for this purpose. The primary abdominal incision is then closed preferably with buried layer sutures of No. 35 alloy steel wire. The first of these procedures prevents the passage of fluids, gas and food from the stomach into the lungs while secretions from the cardia, esophagus and lungs are vented upon the surface of the body. The second or gastrostomy enables the child to be safely fed.

3 At the same time or if the infant is in poor general condition the following day a cervical esophagostomy is formed. A 2 or 3 cm transverse incision is made over the medial border of the sternomastoid muscle about 1 cm above the clavicle. The sternomastoid and carotid sheaths are retracted laterally the thyroid gland and trachea medially exposing the esophagus which is relatively large and thick in the infant. If possible the closed end of the esophagus which usually lies about the level of the clavicle is freed brought into the incision opened and a very small Pezzer catheter with half of the tip cut off is introduced into the esophagus where it is held by a purse string suture. If the esophagus is

is anchored by sutures. If the lower end of the esophagus

cannot safely be freed, the side of the esophagus is to be brought up to the skin incision, where it is anchored and the tube introduced. A subcutaneous tunnel is desirable to limit leakage. The baby may now be fed by a bottle or at the breast. The food mixed with saliva which on deglutition immediately escapes through the tube from the neck, is collected in a test tube or other small receptacle and then poured through the gastrostomy tube into the stomach. This worked in a very satisfactory way with our patient.

Later in life a larger tube may be connected directly from the esophagostomy in the neck with the gastrostomy opening and finally a subcutaneous epidermal lined tunnel formed, connecting the esophageal opening in the neck with the stomach. These three operative procedures may be carried out under local anesthesia, using $\frac{1}{2}$ or $\frac{1}{4}$ per cent procaine solution with out undue shock.

Case V Congenital Atresia of the Esophagus Treated by Division of the Stomach, Gastrostomy and Cervical Esophagostomy—Baby Jean E., born January 21, 1937, was unable to swallow since birth. From all attempted feedings there was coughing, choking and gagging as the mouth filled with frothy mucus. The second day after birth, the child was referred to the Hazelton State Hospital where a roentgen study was made and a congenital atresia of the esophagus recognized. The child was then transferred to the Chevalier Jackson Bronchoscopic Clinic of Temple University, January 24, 1937. On admission the baby had a temperature of 103.8° F. and weighed 6.5 pounds. The next day when four days old the abdomen was opened through an upper vertical left rectus incision and two silk threads carried about the upper segment of the stomach which was pulled into the wound and divided
 —ment of the stomach—

above the clavicle across the anterior edge of the left sterno mastoid muscle. The muscle and the carotid sheath were retracted laterally, the thyroid and trachea medially and a relatively large, thick esophagus readily identified and brought to the level of the skin where it was sutured. A No 10 French

soft rubber catheter was inserted into the side of the esophagus for 2 cm where it was held by a purse string suture. On giving the infant water by mouth this promptly escaped from the tube



Fig. 485—Case V. Congenital atresia of the esophagus. The upper segment of the esophagus ends in a blind cervical pouch (C). The lower segment passes from the bifurcation of the trachea into the stomach. Probe AA passing through the larynx, trachea and cardiac end of the stomach shows the large opening between the trachea and lower esophagus. Probe B passes from the pharynx through the surgical opening made in the side of the upper segment of esophagus.

without cough or leakage, the skin was lightly closed. It was now possible to feed the child very satisfactorily by mouth, the swallowed food being first collected in test tubes and then transferred to the stomach. On February 3, there was leakage

around the esophagostomy opening and a new tube was inserted carried under the skin and brought out 4 cm. below the previous opening for better support. On February 5 the abdomen was distended and the child in poor condition. On examining the abdominal wound it was found that the proximal end of the stomach had retracted and the ligature had slipped from its end permitting the contents to flood the peritoneum. The peritoneum was drained and the gastrostomy of the distal end of the stomach revised so that a 10 F catheter tube inserted at the lesser curvature was brought through the skin just above



Fig. 456.—A: arrangement of tubes in Case V. A: Esophagostomy tube. B: gastrostomy to distal segment of stomach. C: drainage proximal end of stomach.

the ensiform. The infant died the evening of February 5 twelve days after admission from generalized purulent peritonitis. As the amount of fluid secreted by the cardiac segment was large this end should have been made as small as possible. Both segments should have had gastrostomy tubes from the beginning and about the points where the tubes were brought through the skin the sections of stomach should have been securely sutured to the parietal peritoneum. With these improvements it is felt that the procedure as outlined is worthy of further trial.

CLINIC OF DR CHARLES F NASSAU

JEFFERSON HOSPITAL

TREATMENT OF THE RUPTURED APPENDIX

APPENDICITIS is the most common infective lesion which develops in the abdomen and therefore warrants careful consideration in the diagnosis of any acute abdominal condition. It must be borne in mind that in fulminating types of infection, perforation may occur within six or seven hours after the onset of symptoms.

In the aged and in the patient with an abnormally placed appendix errors and delay in diagnosis are common. It is well known that the mortality of appendicitis as it exists in the United States is not decreasing. This is, of course, too often due to failure of the patient to call the physician in time or failure of the physician to make a correct diagnosis.

It is an incontrovertible fact that those patients who, in their attempt at self medication have taken a laxative, and those patients to whom physicians have given laxatives, are the ones in whom perforation occurs more rapidly, sometimes with fatal results. A perforation occurring naturally is always a far better operative risk than the one in which the bowel contents are in a fluid state and where active peristalsis exists as the result of purgation.

There has been much controversy as to the proper time to operate in acute appendicitis. While it is universally agreed that all early cases demand immediate operation, disagreement, however, arises as to whether to perform an immediate operation or to carry out the Ochsner conservative therapy in those patients who enter the hospital three or more days following the onset of symptoms. Some surgeons report as good results with immediate operation, after preparation of the patient, as do others by the deferred operation with indicated treatment. It is possible that the lack of agreement among surgeons rela

around the esophagostomy opening and a new tube was inserted carried under the skin, and brought out 4 cm below the previous opening for better support. On February 5, the abdomen was distended and the child in poor condition. On examining the abdominal wound it was found that the proximal end of the stomach had retracted and the ligature had slipped from its end permitting the contents to flood the peritoneum. The peritoneum was drained and the gastrostomy of the distal end of the stomach revised so that a 10 F catheter tube inserted at the lesser curvature was brought through the skin just above



Fig 486 — Arrangement of tubes in Case 1. A Esophagostomy tube B gastrostomy to distal segment of stomach C draining proximal end of stomach

the ensiform. The infant died the evening of February 5 twelve days after admission, from generalized purulent peritonitis. As the amount of fluid secreted by the cardiac segment was large, this end should have been made as small as possible. Both segments should have had gastrostomy tubes from the beginning and about the points where the tubes were brought through the skin the sections of stomach should have been securely sutured to the parietal peritoneum. With these improvements it is felt that the procedure as outlined is worthy of further trial.

The incision along the lower portion of the lateral border of the rectus muscle, in spite of every care, frequently results in nerve injury. Furthermore, the course of variations of the deep epigastric vessels are such that they are commonly injured and this accident may prove very annoying to the surgeon. There is more handling of the bowel and therefore more likelihood of disseminating infection. Postoperative hernias following the lateral rectus incision are far more common than is generally believed.

From an anatomic viewpoint therefore the superiority of the McBurney incision for the removal of the appendix has much in its favor. I am convinced from an experience of many many years that the use of the McBurney incision is actually life saving in many instances.

Operation.—The McBurney incision aided by careful retraction of each layer of the abdominal wall gives clear access to the abdominal cavity. In the presence of severe infection of the appendix the tissues of the abdominal wall are often edematous. Once the appendix is visualized it is usually unnecessary to expose any great area of either large or small bowel. Loops of small bowel which may appear in the depths of the wound are immediately tucked out of sight in the abdomen and maintained there by a small gauze pack. Peritoneal fluid and pus is carefully removed by means of suction. Flakes of exudate on the wall of the bowel are not disturbed.

The appendix should always be removed if possible. It is a common experience that if the appendix is removed the patient's recovery from operation and subsequent convalescence is much smoother. Where an appendix forms part of the wall of an abscess it must be accurately determined whether it can be removed without breaking through the abscess wall into an area of clean peritoneum.

It is sometimes possible to split the thickened and inflamed peritoneal and muscular coats longitudinally leaving them in place while still shelling out the submucous and mucous coats. In this way the outer coats of the appendix are removed.

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tive to the two procedures, the immediate operation and the deferred operation, is more apparent than real

It has been my practice to operate immediately in all cases except those showing an absolutely silent abdomen or those who are practically moribund

There is a small group of patients in whom delay in operation is the wiser course. The abdomen is distended and does not move with respiration, reflexes are absent, peristalsis is inaudible, and there is associated extreme sepsis. Here, the Ochsner treatment may cause localization of the infection which can be drained at a later date

In a recent survey, made in one hospital, localization occurred in the pelvis eighteen times under this treatment, incision and drainage by rectum resulted in 17 recoveries and 1 death

It is generally recognized that every patient should be properly prepared before an operation is performed which preparation and treatment may be what some surgeons regard as the deferred operation. The procedure is adapted to the patient rather than the patient be adapted to any fixed preparation and operation. However, the indiscriminate use of delayed treatment in acute appendicitis with perforation may do great harm

Incision.—The McBurney incision for a number of reasons, is the most preferable (1) The muscles are split in the direction of their fibers (2) with care there is no division of any nerve supply, (3) there is less exposure of the abdominal contents, (4) the exposure is often directly over the appendix (5) if care is taken in separating the layers of the abdominal wall, adequate exposure is obtained (6) the deep epigastric vessels are rarely encountered (7) drainage is lateral to the small intestines, thus decreasing the possibility of secondary intestinal obstruction (8) the incidence of postoperative hernia is much lessened

Drainage material consists of gauze and a dressed drainage tube. The dressed drain consists of a heavy-walled pure gum tube 1 cm in diameter. One end of the tube is cut fishtail fashion and at least two openings are made in the wall of the tube, 1 and 2 cm from the end. This tube is rolled loosely in several layers of iodoform gauze with the end of the tube protruding 1 cm beyond the selvedge of the gauze. This is then placed in a piece of Penrose tubing. In the absence of Penrose tubing, a piece of rubber dam can be rolled around the gauze overlapping it sufficiently to form a tube. After the dressed drain is placed, plain or iodoform gauze is used to keep the wound open and the tube in place.

It is futile to employ narrow strips of gauze for drainage. A piece of gauze is folded in such a manner that the rough edges are turned in, then rolled loosely to form a soft rope or large wick. This soft rope of gauze is used to line the outside of the drainage bird's nest. It is stuffed and folded in as it is placed in such a manner that in removing it no direct pull comes upon any great length of it at one time.

As the wound is not to be sutured, this is the only method I know that absolutely insures against the possibility of any coils of bowel forcing their way out of the abdomen and yet allows free drainage. After the infected area has been surrounded by gauze, there is an opening at the bottom of which is the lateral pelvic wall. It remains therefore only to introduce sufficient gauze to act as a keystone to hold the surrounding packing in place. If pus is found to extend up along the outer side of the ascending colon, this area can be adequately drained by introducing a large cigaret drain through a stab wound in the loin.

Provided the drains are properly placed and no subsequent sloughing of the cecum occurs, the development of a fecal fistula is a rare incident. If the cecum has been kept free from the abdominal wall, any fecal fistula that may form usually heals spontaneously.

It has often been stated by some surgeons that gauze will not drain pus, also that after a few hours, gauze drainage is useless on account of the clogging up of the capillary action of the drain by thick discharge. I do not know of any way that I can controvert these arguments. I do know, however, that

and experience than the removal of a violently infected and adherent appendix. With care and proper surgical skill, practically all appendices can be removed without adding to the operative mortality.

If there is much infection, simple ligation of the base of the appendix will suffice. The use of the cautery or carbolic acid is not vital. Purse string or other occluding sutures are

open demand the use of absorbable ligature on the stump of the appendix.

It is important to determine at this time whether a fecal concretion or other foreign body may have escaped from the appendix and lies free in the abdominal cavity. It should be removed, if at all possible, since its presence may lead to the formation of a sinus that will persist until this foreign body is removed.

The wound is left completely open in all badly infected cases, no sutures whatever being used. Such wounds clear up

distance and comes to the surface unobstructed. The most important factor about the drainage of such wounds is the proper placing of the drains. The dressed drainage tube should be introduced first. Having the wound edges well retracted and any coils of small bowel pushed toward the midline, the dressed drain is put in place by grasping the lower end of it in a long forceps and sliding it along the pelvic wall to the bottom of the pelvis. If the operator is unable to do this without having the drain be

placed that the appendix stump rests on the lateral wall and is removed from actual contact with the drains.

The amount of chlorides required to maintain electrolyte balance can be accurately gauged by estimation of blood chlorides and the alkali reserve 5 to 6 Gm being necessary each day

In the attempt to maintain water balance with large amounts of intravenous normal salt solution the patient may be supplied with an amount of sodium chloride far in excess of the requirement and if persisted in, it will lead to edema and diminished tissue resistance. Since the isotonic solution 5 per cent glucose is often administered in normal salt solution the overload of chlorides may remain the same unless the amount of chlorides in the solution introduced is carefully measured.

Continuous intravenous with 2 per cent glucose in normal salt solution is the preferred method. Should extra glucose be indicated it is best administered separately in concentrated solution. Intravenous solution introduced at the proper rate will not overburden even the damaged heart.

When hypodermoclysis is used it can be successfully introduced through small caliber needles without discomfort to the patient. At this point I wish to condemn the widespread method of introducing fluids into the thigh. It is a needlessly painful procedure. There is no room for the fluid on account of the lack of any loose cellular space. Instead of using the thigh hypodermoclysis needles should be introduced in the midaxillary line about 6 inches below the lower border of the axilla. Absorption is extremely rapid and tremendous amounts of fluid can be introduced into this area with little or no pain.

In desperately ill patients exhibiting a high degree of sepsis small transfusions of whole blood may be given.

No attempt is made to hurry the removal of the gauze. The so called keystone piece may be removed first without danger to the patient and with but little pain. When removed it should be immediately replaced by a smaller piece of gauze. It is my practice to loosen and remove some of the packing every other day. When any piece of the original gauze is completely removed a smaller piece of fresh packing should be introduced.

The dressed drain is always completely removed on the fifth or sixth postoperative day and is immediately replaced by a gauze wick that should extend to nearly the same depth as the

much experience has shown me that where a proper drain or if you wish to call it so, a pack is introduced into the peritoneal cavity, the site of a peritonitis, there is not only immediate but profuse and continuous drainage for a period of forty-eight to seventy two hours and sometimes ninety six hours. That gauze will drain like a pump is of course, a foolish notion.

The use of rubber dam to surround a gauze pack largely defeats the very purpose for which the pack was introduced. Inadequate drainage is worse than no drainage at all. I have had the opportunity to observe a number of patients who have unquestionably died as the result of inefficient drainage, therefore, until such time as I can learn a safer way to drain the peritoneum as the result of a ruptured appendix I shall continue to use this method of drainage.

The coffer dam drain as originally used by Mr. Lawson Tait, and later by some of his students particularly the late Dr. Joseph Price, of Philadelphia has, I believe, been responsible for saving many lives.

Postoperative Treatment — Morphine is administered in dosage to keep the patient comfortable and free from pain but never to the extent of complete narcotization.

Liquids by mouth are withheld until the tone of the bowel is restored.

Wangensteen syphon drainage is used if there is any gastric distention present. With gastric syphonage in place, fluids may be given by mouth since the fluid is constantly removed by the continuous suction. In some cases intestinal distention may be reduced through decompression by means of syphonage established by a tube in the rectum.

Postoperatively, the patient should receive an average of from 2500 to 3000 cc. of fluid daily in order to compensate for the daily loss of water by urine, stool and insensible loss. To this may be added abnormal loss if there is vomiting or excessive sweating. The average patient should receive at least 2500 cc. of fluid during the first twenty four hours after operation. Subsequently, he should receive approximately 2000 cc. of fluid daily, assuming, of course that there is no abnormal water loss. In brief, water balance is maintained by careful observation of the patient and estimation of the loss of fluids. As Cabot aptly notes, "There is some intellectual process involved."

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The dressed drain is always completely removed on the fifth or sixth postoperative day and is immediately replaced by a gauze wick that should extend to nearly the same depth as the

drainage tube originally extended. This wick is removed gradually in order to avoid the formation of any residual abscess.

As a rule, the wound is completely freed of all drainage about the fourteenth to the sixteenth day after operation, sometimes very much earlier.

Patients in whom gauze packing has been used must never be given laxatives since it may induce intestinal obstruction owing to the overactive peristalsis at some point of adhesion.

I know that gauze packing in itself rarely or never causes postoperative obstruction. I have seen postoperative obstruction in 3 patients to whom laxatives had been given by the cooperating physician without the knowledge or consent of the surgeon.

The surgeon should not be worried by the idea that the patient will starve. Too early attempts at feeding are injurious to the patient. After forty-eight to seventy-two hours or sometimes not until the fourth or fifth day, when the patient has started to pass gas, the tongue is beginning to clear, the temperature and pulse rates are approximately normal, then and only then should food of any kind be given the patient. Tea and coffee, with sugar but without cream, and grapefruit juice are usually well borne at this time. After the first few days carbonated water and ginger ale can be given. The patient may be allowed to chew pieces of rare steak, the dry pulp of which is rejected. The very act of mastication brings about a train of physiology that is of tremendous benefit. If the patient is hungry, has a flat abdomen and desires food, then the diet can be increased by giving gelatin, custard, junket, cream of wheat, strained soups, and thin, hard-dried toast with plenty of butter. If this variety of diet is well borne, it can be continued for a number of days, other food being added according to the patient's wish.

Usually about the fourth or fifth day following operation a small purgative enema of 1 ounce of glycerin, 2 ounces of magnesium sulfate, and 3 ounces of water will act efficiently in emptying the lower bowel and give the patient considerable comfort.

When the wound is fairly well closed, there is no reason why the patient should not be placed in a rolling chair, but I

do not do this until all gauze has been removed and the wound edge contracted to a hole no larger than the diameter of a lead pencil

The patient will often ask whether he has to wear a belt. It is in the wide open drainage patient that a properly designed belt will give a good deal of comfort. I have yet to convince myself, however, that the incidence of hernia is decreased by the wearing of a belt. Without a belt the patient may get a hernia sooner. On the other hand I believe that if he is going to have a hernia, the wearing of a belt will not prevent it.

In the rare instance where the appendix has not been removed, the patient should be urged to return for appendectomy within about six months after the primary operation. It is a great mistake to attempt appendectomy a few weeks after the original drainage of a ruptured appendix.

CLINIC OF DR. I. S. RAVDIN

HOSPITAL OF THE UNIVERSITY OF PENNSYLVANIA

PREOPERATIVE PREPARATION OF PATIENTS WITH CHOLECYSTITIS AND HEPATIC INSUFFICIENCY

IN few surgical conditions is the preoperative preparation of greater importance to the final outcome than in the pathologic conditions of the biliary tract requiring surgical therapy. The high mortality in the past can be ascribed neither to less technical skill at operation nor to poorer surgical judgment but rather to the lack of information concerning the pathologic physiology of the processes involved and the manner in which they can best be controlled prior and subsequent to operation.

It is during a state of partial liver insufficiency that many of the patients with cholecystic disease come for surgical aid at a time at which there is perversion of function of this important organ.

FUNCTION TESTS

A large number of tests have been devised to determine the degree of hepatic impairment. The glucose and galactose tolerance tests have been widely used but too often the specificity which certain writers have ascribed to these tests has not been substantiated by other investigators. Alimentary glycosuria and alterations of the sugar tolerance curves are

monium carbonate could be transformed into urea by the liver, the administration of various substances which could be converted into urea have been suggested as a means of determining the liver function. It was supposed that a damaged liver would fail to synthesize amino-nitrogen into urea in direct pro

For the determination of bile pigment retention in the blood we believe the van den Bergh reaction is the most satisfactory method available. Regardless of whether one agrees with McNee and others on the specificity of the qualitative reaction the quantitative portion of the examination remains the most accurate method available in the clinical laboratory for the quantitative determination of hyperbilirubinemia. The icterus index is so easily affected by diet and other factors that we have given up its use on my service, for we have had referred to us a patient suffering from supposed obstructive jaundice with a very high icterus index whose sole trouble was the ingestion of too many carrots.

COINCIDENTAL DISEASES

During the routine preoperative study of the patient numerous conditions which are indirectly associated with the major lesion must be looked for and evaluated. The more important of these are (1) cardiovascular disease (2) diabetes mellitus and (3) renal dysfunction.

Cardiovascular Disease—A considerable number of the patients coming to operation for biliary tract disease have coexisting cardiovascular disease. Some of these patients have varying degrees of myocardial disease. The lesion may have produced no alteration of the cardiac rhythm and only a careful history and physical examination will elicit findings suggestive of a cardiac lesion. Certain of the patients will have extrasystoles while others may exhibit auricular fibrillation.

It must also be remembered that more and more patients are being sent to the surgeon for biliary tract surgery whose major symptoms are those of angina pectoris but who in addition have a history and laboratory findings which strongly indicate that gallstone disease is also present. Evidence is accumulating that when the two conditions coexist it is wise to relieve the patient if possible of his biliary lesion. The marked improvement which so frequently follows adequate surgery will lead to an extension of this practice.

There is also present in many of these patients moderate or severe hypertension with or without a demonstrable cardiac lesion. Some of our patients have come for operation at a time when there were mild to severe symptoms of congestive

portion to the existing liver injury. The tremendous reserve factor of the liver prevents the fulfillment of such a prophecy for Mann has shown that 80 per cent of the liver of the dog can be removed without affecting appreciably the normal urea forming ability of the animal. From the data now available it would seem that the ability to synthesize urea is impaired only when the destruction of the liver tissue is nearly complete a time at which a function test is of little value. Even when amino acids have been fed in large amounts thus putting the liver under an increased strain the results obtained in the presence of moderate liver damage have not been significant.

The tests of hippuric acid synthesis while being perhaps of slightly greater value have not proved as advantageous as we were at first led to believe they might be. Here again excessive liver injury must be present before significant findings are obtained.

The dye tests have often also proved disappointing. Although certain of these such as the bromsulfalein test may be more easily conducted than the more complicated chemical procedures too much reliance cannot be placed upon any of them in the milder forms of hepatitis.

There are several reasons why hepatic function tests have not proved satisfactory for routine use. In an organ whose functional activities are so diversified it is highly likely that no one test will indicate the divergence from normal function of all these activities. The reserve capacity of the liver is so

large that it is now difficult to

determine this

the total liver mass

even though all func-

tion is directed to the liver cells as

the result of operative trauma and anesthesia may be so great as to convert a normally functioning organ into a completely incompetent one. Observations which Vars, Goldschmidt and myself have made show that this may occur in the face of a glycogen level greatly above the normal and with only double the normal fat concentration of the liver.

With such a regime the patient will come to operation better prepared and the surgeon can operate with the assurance that the risk is low and the chances of improvement in the cardiac status after a carefully planned and executed operation are good. While the results may not be as satisfactory as in the thyrocardiacs they definitely approach these.

Diabetes Mellitus—The incidence of diabetes mellitus in our patients with biliary tract disease has been twice as high as the incidence of diabetes mellitus in this community. The causes for this increased incidence are not all clear. A number of factors, however, may contribute to this.

Deaver and others have reported that biliary tract disease results in changes in the pancreas. While they believed that the major changes occurred in the acinar cells, it is not at all impossible that, if these are damaged as the result of biliary tract infection, the islet tissue is likewise affected.

It is generally agreed that long standing cholecystic disease gives rise to changes in the hepatic parenchyma. There result changes in the hepatic cells varying degrees of fibrosis and frequently the infiltration of cells which generally are associated with inflammatory reactions. Furthermore there takes place in many such livers a varying amount of fatty infiltration. This may be of such extent as to replace large amounts of the hepatic parenchyma.

These cellular changes lead to a reduction in the glycogen stores of the liver. Not only are the glycogen stores reduced but after the ingestion of large amounts of carbohydrate the blood sugar may remain elevated for a considerable period as has been shown by Mautner and Ferguson. In fact the glucose tolerance curves in many of the patients with severe hepatic disease are not unlike those seen in the diabetic.

Recently Soskin and his coworkers have shown that the normal liver is the major factor in determining the normal glucose tolerance test. Their results offer a rational explanation for the diabetic type of tolerance curve observed in starvation despite the presence of a normal pancreas. Although the liver is the major factor in determining the glucose tolerance curve it can respond normally to sugar administration only when under the influence of a suitable endocrine balance.

Joslin has called attention to the frequency with which

heart failure Unless the physical examination is carefully done the more obscure evidences of early congestive heart failure may be completely overlooked The enlarged tender liver may be interpreted as due solely to the gallbladder disease The pulmonary rales and the slight pretibial edema may escape a casual examination

Of major importance to the surgeon is the risk involved in operating on this group of patients In our experience the risk is small if the patient is properly prepared for operation In the preparation of the severely handicapped patient the assistance of a cardiologist is of the greatest advantage

The preoperative study in this group of patients in addition to the physical examination should include an electrocardiogram and if possible an orthodiagram A period of absolute rest in bed is of the utmost importance It will reduce the demands which are being made on the heart and will in the hypertensive group as a rule result in a considerable reduction in the blood pressure Many of the operative fatalities which have been considered to have been cardiovascular could have been averted by a few days or weeks of rest in bed for the preoperative period

If the patients are not sleeping well because of abdominal or precordial distress the judicious use of morphine for a few days prior to operation is well worth while and we have not hesitated to resort to it In fact in the patients with congestive failure its use is of paramount importance and failure to realize this may result in a tragedy

In the patients with auricular fibrillation the administration of digitalis is indicated Contrary to the belief of many surgeons digitalis preparations are not indicated except when fibrillation is present There is no evidence that the preoperative administration of digitalis to patients suspected of having myocardial disease without total arrhythmia is of the slightest

digitalization in his hands Furthermore unless an emergency exists operation should be deferred until the cardiologic consultant feels that he has obtained the maximum improvement in the patient's condition

stands the preparation of the diabetic patient for operation and who is willing to take the time to solve the perplexing situation which these coexisting diseases present. This is a field with which the novice is not prepared to cope.

Renal Dysfunction—It is generally believed that hepatic disease is unassociated with renal dysfunction. While in general this may be true there occurs in a considerable number of patients with obstructive jaundice a serious impairment of the functional activity of the renal parenchyma. Under such circumstances the presence of albumin and casts may indicate acute renal injury which may or may not be superimposed upon a preexisting renal lesion.

It is in this group of patients that a low serum calcium may be encountered which is nearly always associated with a serum protein deficiency or with hyperphosphatemia. These are more apt to be present if the patient has had preexisting renal disease. The fallacy of attempting to correct such a calcium deficiency by the administration of diffusible calcium salts is evident when one considers that the ionized calcium is not affected, the non-ionized fraction combined with protein being the fraction which is lost.

In patients suspected of having renal injury a careful survey of this system should be made. This includes a careful microscopic and chemical examination of the urine, the determination of serum protein, the degree of nitrogen accumulation and the urea clearance. Renal concentration tests are frequently of value.

A high blood nonprotein nitrogen is not always of serious significance, especially if the acute lesion is not superimposed upon a preexisting chronic nephritis. For subsequent to surgical therapy the evidences of renal injury may rapidly subside. One is therefore not justified in attaching too great prognostic significance to the blood nonprotein nitrogen concentration unless the entire clinical picture considered at the same time warrants it.

The evidence of renal impairment should in the main be considered as an additional load which has been added to what the patient already is carrying. It must be taken into account in preparing the patient for operation and in determining the anesthetic to be used for operation. And above all it must be

diabetes mellitus occurs in obese individuals and here again the relationship to gallstone disease is striking for a considerable proportion of patients with gallstones are obese. The presence of obesity in these two groups of patients and the increased frequency of diabetes mellitus in the presence of cholecystic disease suggests a more than casual relationship.

In no group of patients with diabetes is standardization more difficult than in those with severe hepatic disease. The damage to the hepatic parenchyma results in a liver mass which is unable to store glycogen in adequate amounts. The fatty infiltration seen in so many of these patients further leads to a decrease in the liver glycogen for under normal condition. As Rosenfeld has shown, a decrease in the liver glycogen leads to an increase in the liver fat.

When standardization is attempted in this group it is common experience that doses of insulin which usually lead to only a moderate reduction of the liver glycogen cause the patient to go into a hypoglycemic state and shock is very frequent. Recurring shock during the period of standardization in this group indicates that the available glycogen stores of the liver are seriously depleted. Regardless of what liver function tests may signify such findings can be accepted as indicative of extensive liver cell injury.

It can thus be seen that the presence of biliary tract disease and diabetes mellitus in the same patient presents problems which may be difficult of solution and which the surgeon is frequently not equipped to control. Just as in the cardiobiliary patient the biliary diabetic patient requires the joint efforts of surgeon and internist if the mortality is to be kept low and the end results satisfactory.

Even when the patient is brought through operation the improvement in the diabetic situation may not be striking. Many of the milder cases may subsequently be carried along on only a moderate reduction of carbohydrates in the diet. The moderate cases may be controlled by a somewhat more rigid diet without insulin but the severe cases with extensive hepatic damage may not be sufficiently improved to do without insulin.

In our patients with coexisting diabetes and biliary tract disease we have obtained the services of an internist who under

bleeding occurs more frequently in patients with obstructive jaundice from malignant lesions especially when the malignancy involves the liver tissue. Hemorrhage is rare in hemolytic or catarrhal jaundice in which conditions liver injury is rarely a prominent feature.

The simultaneous use of glucose and calcium in the preoperative preparation of the patient with hepatic disease has perhaps resulted in a decrease in the incidence of postoperative hemorrhage, but since there is no demonstrable calcium deficiency in these patients it seems highly possible that the beneficial effect has resulted from the glucose alone. For ten years we have used glucose alone and have had the same favorable effects as with the earlier use of glucose and calcium.

We have frequently called attention to the value of blood in the preoperative preparation and postoperative care of the jaundiced patient and have stressed the fact that the primary attention should be directed against the hemorrhagic tendency before bleeding occurs. The exact method by which blood transfusion may prevent hemorrhage in the jaundiced patient if it does this and controls it once it has occurred is not as yet understood. It is possible that some substance necessary in the normal clotting process at present not known may be supplied. It is possible that anoxemia may be a direct or indirect factor. An analysis of our own cases shows that since transfusion has been used before and after operation in the jaundiced patient the mortality from hemorrhage has been reduced by 50 per cent.

The incidence of hemorrhage however has remained about the same although we believe that there has been a marked reduction in the severity of the hemorrhage. All jaundiced patients receive blood before operation. Those mildly jaundiced or jaundiced for only a short period receive 1 or 2 transfusions before operation. Those deeply jaundiced or whose jaundice has been present for a longer period receive from 3 to 5 transfusions prior to operation depending upon the period of preoperative preparation. As a rule from 250 to 300 cc of citrated blood are given at intervals of forty eight hours.

In the postoperative period blood is given once or twice but is continued only if hemorrhage ensues. When it does occur transfusion is resorted to as frequently and in as large

considered in the administration of fluids especially large amounts of sodium chloride which may so tax a renal system which is near the breaking point is to result in renal insufficiency

HEMORRHAGE

The occurrence of hemorrhage in the postoperative period

or sole source of the blood fibrinogen was the liver that a decrease in the blood fibrinogen would be found in obstructive jaundice. This did not prove to be true for in both the dog and man with obstructive jaundice there is no change in the blood fibrinogen from the normal, except when there is an associated infection or anemia when there is apt to be an increase

Quick and his associates have reported a reduction of prothrombin in the blood of jaundiced patients but Eagle has found no deficiency of prothrombin in the blood of seriously jaundiced dogs and patients. There is no calcium deficiency present except when there is an associated reduction of the serum protein. Since under such circumstances the reduction of the calcium is in the nonionized fraction I can see no advantage in administering calcium chloride to the jaundiced patient and I have not used calcium therapy for ten years.

At the present time there is no method which with any degree of certainty will tell us which patients will and which will not bleed after operation. The bleeding and coagulation

in our hands

Since the causes of the hemorrhage after operations for obstructive jaundice are not understood the methods for combating the hemorrhage must have a purely empirical basis. It is well known that fatal hemorrhage in obstructive jaundice is very rare prior to operation. There is moreover no absolute parallelism between the duration of the jaundice and the tendency to hemorrhage. It is believed that the more advanced the liver damage the greater is the tendency toward postoperative hemorrhage and that it is for this reason that

bleeding occurs more frequently in patients with obstructive jaundice from malignant lesions, especially when the malignancy involves the liver tissue. Hemorrhage is rare in hemolytic or catarrhal jaundice, in which conditions liver injury is rarely a prominent feature.

The simultaneous use of glucose and calcium in the preoperative preparation of the patient with hepatic disease has perhaps resulted in a decrease in the incidence of postoperative hemorrhage, but since there is no demonstrable calcium deficiency in these patients it seems highly possible that the beneficial effect has resulted from the glucose alone. For ten years we have used glucose alone and have had the same favorable effects as with the earlier use of glucose and calcium.

We have frequently called attention to the value of blood in the preoperative preparation and postoperative care of the jaundiced patient and have stressed the fact that the primary attention should be directed against the hemorrhagic tendency before bleeding occurs. The exact method by which blood transfusion may prevent hemorrhage in the jaundiced patient if it does this, and controls it once it has occurred is not as yet understood. It is possible that some substance necessary in the normal clotting process at present not known may be supplied. It is possible that anoxemia may be a direct or indirect factor. An analysis of our own cases shows that since transfusion has been used before and after operation in the jaundiced patient the mortality from hemorrhage has been reduced by 50 per cent.

The incidence of hemorrhage however, has remained about the same although we believe that there has been a marked reduction in the severity of the hemorrhage. All jaundiced patients receive blood before operation. Those mildly jaundiced or jaundiced for only a short period receive 1 or 2 transfusions before operation. Those deeply jaundiced or whose jaundice has been present for a longer period receive from 3 to 5 transfusions prior to operation depending upon the period of preoperative preparation. As a rule from 250 to 300 cc of citrated blood are given at intervals of forty eight hours.

In the postoperative period blood is given once or twice, but is continued only if hemorrhage ensues. When it does occur transfusion is resorted to as frequently and in as large

amounts as are needed to maintain an adequate blood volume. We have transfused a single patient as many as twenty two times in the postoperative period before recovery took place. With such a regime in the pre- and postoperative period the incidence of hemorrhage may still remain high, but the mortality from hemorrhage will be strikingly reduced.

GLYCOGEN FAT STORES OF THE LIVER

In the presence of hepatitis, with or without obstructive jaundice, the glycogen stores of the liver may become seriously depleted. The actual extent to which the storage of glycogen is interfered with may not be evident by any test, except when the damage is so great that function tests add only confirmatory evidence.

The hepatic injury that is observed in obstructive jaundice and the later stages of hepatitis not only results in a liver whose glycogen stores are low, but in a liver in which, under the best of conditions of preparation we may not be able to improve the stores prior to the release of the obstruction. In the experimental animal with common duct obstruction it is occasionally possible to increase the liver glycogen to 2.5 per cent or one half the normal but as a rule the amount is considerably below this level, glycogen concentrations of 0.5 per cent being not unusual.

As the liver glycogen is decreased the liver fats are apt to increase especially when there is available a large amount of subcutaneous fat. This inverse relationship between glycogen and fat is of the greatest significance to the patient for as Goldschmidt, Vars and myself have demonstrated it is the amount of liver fat which conditions the occurrence of liver

if it will lead to glycogen deposition with a resultant decrease in liver fat. Data which Johnson, Zintel and I will soon publish lead us to believe that even under the best conditions of preparation the liver fat is not in many instances greatly reduced.

That this would be true we should have expected for as long as the impediment to a nearly normal activity of the liver

cells is present as it is in obstructive jaundice glycogen deposition in large amounts cannot take place. Even when small amounts are deposited these are rapidly mobilized by the very process which damaged the cells and mobilized the liver glycogen originally, the ductal occlusion.

It is therefore necessary that in order properly to prepare our patients some lipolytic substance easily and economically administered be used. We believe at the present time that the addition of protein to the diet will help to decrease the liver fat. Under experimental conditions Channon has shown this to be the case. For the past year we have added protein to the preoperative diet to the extent of 15 to 20 per cent of the total calories administered. While we are not as yet sure that we are accomplishing our objective we believe that the principles are correct and that the patient stands an excellent chance of coming to operation with a reduced liver fat even though the liver glycogen may not be greatly increased.

In addition to the diet we administer a 5 to 10 per cent solution of glucose in amounts varying from 1000 to 3000 cc per day in the preoperative period depending upon the severity and the length of the jaundice. This is given by a slow continuous intravenous drip to prevent glucose from spilling over in the urine. Generally the glucose is dissolved in distilled water but if chlorides are necessary a portion of the glucose is given in normal salt solution.

TIME OF OPERATION

The preoperative preparation of the patient is therefore directed toward combating the disturbances in function of various viscera and toward restoration of a more normal function of liver, heart, kidneys and pancreas.

The optimum time for operation is as Waltman Walters has pointed out when the level of bile pigment retention in the blood is more or less stationary. The significance of this observation is only too frequently overlooked. A patient who is operated on in the face of a rapidly rising bile pigment concentration in the blood is not as well able to withstand the additional trauma of operation as is the patient whose blood bilirubin shows a constant level. If the blood bilirubin is increasing or decreasing we wait until a plateau has been reached before operation.

ANESTHESIA

The choice of the proper anesthetic for patients with hepatic insufficiency is of the greatest importance. It has been well established for many years that chloroform should not be used in these patients. We have good evidence that ether also can cause severe damage in the presence of anoxemia. Because of the slowing of the vascular stream in ductal obstruction there is local anoxemia of the liver tissue. Some of the violent postoperative reactions after the use of ether are without doubt due to the damage of the liver cells. Nitrous oxide and oxygen usually fails to give sufficient relaxation unless it is pushed to the point where oxygen want is encountered.

For these reasons we use spinal anesthesia in the great majority of our cases. It provides excellent relaxation without damage to the liver cells. Carefully administered it has few contraindications and we believe its use has resulted in a lowering of our mortality after operations for common duct obstruction.

I have discussed a few of the factors which we must consider in preparing these desperately ill patients for operation. Regardless of the skill of the operator, disaster may occur if the surgeon does not understand the surgical physiology of the lesion and the pathologic physiology which accompanies it.

CLINIC OF DR. THADDEUS L. MONTGOMERY

JEFFERSON MEDICAL COLLEGE

THE TREATMENT OF SEPTIC ABORTION

INFECTED abortion is the largest single cause of maternal death. It is responsible for one fourth of all obstetric fatalities, and produces untold suffering and infertility in the patients who survive. There is no apparent sign of lessening in this phase of mortality. In Philadelphia (see table) there has oc-

SEPTIC ABORTION DEATHS IN PHILADELPHIA (1931-1936 inclusive)

Years	Deaths from septic abortion	Per 10,000 live births	Per cent of total maternal deaths
1931	13	13.0	23.42
1932	55	17.1	20.59
1933	42	14.2	23.20
1934	52	17.4	26.26
1935	46	15.3	24.86
1936	48	16.1	23.18
Total	306	16.5	23.58

curred a slight decrease in deaths in recent years, but this decrease is simply proportionate to the lessening of general birth rate and septic abortion still operates as the preventable factor in 23 per cent of fatalities. From this cause alone 306 patients have succumbed in one half dozen years.

In these figures there is little cause for optimism, but there is always hope for the future, and as I undertake a study of treatment I wish to venture a prophecy—that despite the dis-

couraging features of the picture, the next two years will show improvement, and soon we will be able to demonstrate a downward trend in mortality. The belief is based upon three observations: (1) that the prevention of undesired pregnancy is becoming a recognized fact; its methods are being taught to women in all strata of society, and its effect in replacing or eliminating induced abortion will be noted in the near future; (2) that a fruitful campaign is being waged among sexually mature women to illustrate the dangers of criminal abortion; and (3) a fund of knowledge is accumulating as to the nature of infecting organisms³ in septic inflammation, and more effective agents are being introduced for treatment.

In no other field of medical practice is the adage more applicable that "an ounce of prevention is worth a pound of cure." The physician plays an important role in prevention. For the distracted patient who finds herself pregnant under circumstances which seem to her a calamity, the physician must take the time, have the patience, and leave no stone unturned in an effort to deflect her thoughts from the idea of arresting pregnancy.

In 65 per cent of septic abortion deaths in Philadelphia criminal induction was acknowledged. In 90 to 95 per cent circumstances point toward its actually having been present. The average woman has no conception of the danger she runs in a criminal induction. In her disturbed state of mind it is difficult to make her comprehend. It is too bad that one cannot present to such a distracted patient the testimonials of thousands of women who have died with the cry upon their lips. If I had only known—or of others who in later life have wept with despair at their incurable sterility.

If the patient seems amenable to suggestion, insist upon delay at least; plead with her for a few days of reconsideration. Set a definite time for a second consultation and trust that as the troubled mind quiets, what has been said may find a resting place.

The time does not seem far distant when, as an additional measure of prophylaxis, the physician may be called upon to instruct patients in the technic of contraception. Public opinion seems to be moving in this direction despite our varying opinions—social, ethical, religious, or political. Partners

in wedlock seem bent upon controlling the time and the frequency of childbearing, and as the methods of prevention become more convenient and effective, they will doubtless resort to them and there will be less call for induction of abortion

WHEN IS AN ABORTION SEPTIC?

Since the title of this paper specifies the treatment of a certain type of abortion, and since the principles of treatment in that type are quite different than in the others, it is well to consider first what constitutes a septic abortion what are its symptoms, its signs, what briefly are the points in its diagnosis

In every instance in which a history of mechanical interference is elicited, one may presume that the patient is infected—potentially in all cases, actually in many—and proceed on that basis until convinced otherwise Temperature reaction, fever, is a frequently employed but undependable index of infection Its presence indicates merely that the heat controlling centers of the body are affected by a toxin The toxin itself may be metabolic in origin putrefactive in origin or septic in origin Affected thereby, the temperature may rise to 103° F on one day and fall to normal the next be sustained till the uterus evacuates itself, or continue until the death of the patient

Of greater importance is the reaction of the pulse and its relationship to temperature Temperature elevation in the presence of a full bounding pulse (even though the latter be rapid) suggests a metabolic poison or the toxin of a feebly infective organism Temperature reaction with a thin, rapid pulse is gravely portentous and indicates a rapidly spreading infection with highly virulent organisms Throughout the course of infection one finds in the blood vascular tree the truest indicator of serious progression the quickened beat the decreasing volume, the thready impulse, the imperceptible stream with cold and clammy skin the ultimate collapse of vascular tree with transudation of serous elements into the parenchyma of vital organs

Jaundice is a portentous sign also To a faint degree it may be present in severe infections with the hemolytic streptococcus In deeper shades and upon rapid development it suggests the presence of the Welch bacillus Its presence is always an indication of rapid blood destruction and virulent

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medical study—with the top of the head and proceeding systematically to the soles of the feet. Only by so doing can one avoid the embarrassment of overlooking manifestations of importance. The local parts are properly prepared, a culture is collected from the lochia and the pelvis is gently explored by the bimanual method. Particular attention is paid to the size of the uterus, the degree of dilatation of the cervix, the protrusion of material from the external os, as well as to the local evidences of inflammation. Provisions are then made for culture of the blood, culture of the urine, complete blood count and blood typing.

The bacteriologic diagnosis of the infecting organisms is of the greatest importance for the ultimate recovery of the patient may depend upon the effect of specific therapy. Active treatment does not wait upon bacteriologic diagnosis but its ultimate specificity may depend upon it.

SYSTEMIC THERAPY

The battlefield of infection lies in the patient's tissues and the ultimate outcome depends upon the elements of systemic resistance. Therefore while in the instance of spontaneous complete or incomplete abortion the management of the local condition is a matter of importance in septic abortion the preservation—the nurturing—of systemic factors of resistance is the main consideration. For this reason I have chosen to consider first the various forms of systemic therapy.

Under normal condition of health the body presents a natural resistance to the ordinary types of infection. This resistance lies in the serous and corpuscular elements of the blood and in the fixed tissues of the body. When the system loses vitality through worry, inanition and hemorrhage, when it is subject to massive introduction of bacteria, or to invasion of peculiar and unusual types of bacteria, the factors of resistance are quickly broken down.

Logically the first step in therapy is to provide for the patient an environment which is conducive to rest and an intake of food and fluid which will restore normal body metabolism. To these ends complete isolation is essential for it serves the dual purpose of removing the patient from disquietude and noise and of separating her from other patients.

infection. In addition to these general observations one needs scarcely mention the anxious expression and the abdominal rigidity of general peritonitis the coated tongue and the lethargy of toxemia the confusion and the stupor of far advanced infections.

Locally, the infection of abortion may or may not present the classical symptoms of inflammation. This brings up the question of all forms of manipulation in infected abortion there being those who advise against even the performance of a diagnostic bimanual examination.

To this question I can only reply that I do not like to be in the dark in the treatment of disease, that personally I feel that there is more to be gained by having knowledge of the local condition of the parts than is lost in the manipulation necessary to ascertain the facts. However the examination must be made with the utmost gentleness and the parts prepared and the examiner scrubbed as carefully as would be the case for vaginal examination during labor.

Fixation of the uterus tenderness and induration in the region of the parametrial tissues fulness in the posterior cul de sac tenderness and increased muscle resistance in the lower abdomen are all definite indications of the presence of infection and of its having spread beyond the confines of the uterus. Purulent discharge which reveals upon smear and culture the presence of virulent types of bacteria is additional evidence of infection. However many or all of these signs may be absent in many instances of infection and particularly in involvement with the hemolytic streptococcus are the local signs few and insignificant. Such virulent organisms may penetrate the endometrium and enter the uterine sinuses and veins without leaving a trace of local tissue reaction and no evidence of vaginal discharge other than a thin watery exudate.

STEPS PRELIMINARY TO TREATMENT

The first steps in management of septic abortion then consist in a diagnosis based upon systemic and local examination. A detailed history must be taken and special effort made to secure from the patient a witnessed statement as to how and by whom her abortion was committed. A thorough physical examination is then to be made starting—as one would in any

creates a slight nonspecific protein reaction which stimulates the patient's own resistant bodies. If hemorrhage has been severe, the first transfusion should be a solid one of 500 to 600 cc. subsequent transfusions may, and in the presence of severe infections should, be administered every third day in amounts up to 200 to 250 cc. and the patient's blood count maintained at a level well above 70 per cent of hemoglobin and 3 750 000 red blood cells.

SPECIFIC THERAPY

The dream of therapeutic practice is a specific remedy for every disease, a specific antiserum for every bacterial infection. Needless to say we are far short of that goal. While commendable progress has been made in the sorting of bacterial strains, yet increasing knowledge also has revealed how exquisitely complicated is the whole problem of immunity and its establishment against the many families of bacteria. In only a few instances is bacterial growth amenable to control by serum administration. Nevertheless, modern methods of treatment are so dependent upon a recognition of the type of infection that bacteriologic study and sorting is essential. For practical purpose we are of the belief that culture procured from the mouth of the uterus represents with sufficient accuracy the predominating type of infecting organism.

In a recent bacteriologic study of 500 consecutive abortions T. K. Brown and George A. Hunt² point out the importance of the anaerobic organisms in the septic infection of abortion. According to their studies, where intra uterine culture was positive, anaerobic organisms were found in 53 per cent of cases and anaerobic growths in 92 per cent. Of the aerobic organisms *Bacillus coli*, *Staphylococcus albus* and *aureus*, a spore forming bacillus, diphtheroids, and nonhemolyticus were the most frequently found in the mixed group of infections. In 2 instances the hemolytic streptococcus was found in pure culture and in both the patient died. In 7 instances the hemolytic streptococcus was found in mixed cultures and of these cases 2 died.

Unless the infection be associated with scarlet fever, there are no available specific antisera. Polyvalent serums have been employed for many years with indifferent success. Occa-

who might be infected by her discharges. Absolute rest in bed, the head of the bed elevated to facilitate drainage and localization, as in "White's" or "Fowler's" position—best to elevate the entire head end of the bed with pins or blocks—is the rule. Pain is relieved by the hypodermic injection of opiates when required, and mental rest provided by the rectal administration of bromides or chloral in milk.

Competent and constant nursing care is essential. "Isolation" does not mean "oblivion." The septic patient requires more care than 3 normal patients, and the treatment will be a failure unless the essential help is secured. The first duty of the nurse is to see that the patient receives by mouth as much of nutritious food and as great a variety of essential food elements as her stomach will tolerate. This should include protein, carbohydrate, minerals and a limited amount of fat. Feedings should be administered every four hours. If the appetite lags, each meal can be preceded by the administration of 5 to 10 units of insulin. The fluid intake should be sufficient to establish a daily urinary output of at least 3 liters. This should be alkalized. Sodium bicarbonate if well tolerated, may be administered in proportions of 1 drachm to 8 ounces of fluid. Peritonitis and profound toxemia may, of course, interfere for a time with the retention of food and fluid in the stomach. Under these circumstances resort must be taken to the parenteral route. Fifteen hundred cc of normal salt solution may be administered by hypodermoclysis twice daily and 300 cc of 10 per cent glucose given twice daily by vein, or 5 per cent glucose in normal saline given by continuous drip into the vein. No form of specific or local treatment will prove successful unless due attention is paid to these elemental points in general therapy.

Important among the general supporting measures is transfusion. Provision should be made for it by typing the patient upon her admission and arranging at once for the selection of donors from family or professional sources. Transfusion serves a number of purposes. First it restores an important tissue, of which the patient may have been deprived by hem-

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The pulse rate, which was 110 to 120 on admission, has gradually quickened to 140 and the pulse is of low tension. It presently becomes soft and running, heralding complete peripheral circulatory failure with ice cold sweating extremities deepening cyanosis, increasing thirst, rapid shallow respirations and terminal restlessness. The patient, who is now completely prostrate, may appear physically more dead than alive, but a usual and striking feature is her maintenance of a clear consciousness to the last.

"This syndrome, which can develop with amazing speed, I believe to be pathognomonic of infection by *Cl. welchii* or an anaerobic bacillus of its group.

* * * * *

"At one end of the scale is classical post-abortal gas gangrene, with its rapid development of anaemia, bronze icterus, methaemoglobinaemia and methaemoglobinuria and due predominantly to the effects of the bacterial haemotoxin. This syndrome was present in 45 per cent of our post-abortal cases.

"At the opposite end of the scale are puerperal physometra with its uterine pain and cataclysmic collapse and metastatic muscle gas gangrene, both of which are surely dictated by the bacterial myotoxin.

"In intermediate position, but tending toward the latter group, lie the majority of puerperal cases in which the effects of the bacterial haemotoxin are considerably in abeyance. In seven of our eight puerperal subjects and in the greater number of fatal puerperal cases in the literature, jaundice, haemoglobinaemia and haemoglobinuria have been absent throughout.

* * * * *

"Coincident with diagnosis 40 000 international units of *Cl. welchii* antitoxin should be given intramuscularly as a routine, followed as soon as possible by 40 000 to 60 000 units intravenously in 20 ounces of normal saline or 10 per cent glucose in normal saline.

"Intramuscular injections of 40 000 units should be repeated every twelve hours for at least three days in serious cases, after which daily injections are usually sufficient, and may be continued for a week or more as necessary.

sionally a brilliant result has been observed, but in general the therapeutic value of the polyvalent antiserum is questioned. Personally I have never seen any beneficial action from it in well-established infection with blood stream involvement. I have often used it in incipient and early infections before there was extension to adjacent tissues, and also in presumably and potentially infected cases. In these I am of the impression it is of some value, for I have never seen generalized infection develop when it was so employed. For this purpose, 25 cc of the polyvalent antiserum is injected into the muscular tissue of each thigh anteriorly at the midlevel of the vastus medialis. The injection may or may not be repeated in forty eight hours according to the exigencies of the individual case.

For the more rare types of abortion which follow or complicate pneumonia and in which the local discharge contains the pneumococcus, the organisms should be studied as to type and the appropriate antipneumococcic serum administered.

In this consideration of the forms of specific therapy, attention must be directed to the value of specific antitoxin in infections with the Welch bacillus. While this type of infection appears rather rare in this country yet cases crop up now and then, and perhaps some are overlooked. In a recent number of the Journal of Obstetrics and Gynecology of the British Empire,⁵ Arthur Hill has presented such an explicit description of the symptoms, signs and treatment of this dread disease that I assume the privilege of quoting several paragraphs of his excellent monograph.

The typical course is described as follows:

"Within two or three days of an abortion showing some of the general and local signs of sepsis a woman develops jaundice which becomes most marked on the face and body, least marked on the legs. This rapidly deepens and is soon accompanied
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⁵ Catheterization removes an ounce or two or possibly but a few cubic centimeters of a strongly acid port wine colored

Experimental injection of mice demonstrates that sulfanilamide provides a protective influence against and curative effect for massive infections with virulent streptococci. A wide field of clinical usage is being explored. Inasmuch as the most specific effect of the remedy is noted in infections of the hemolytic streptococcus it should prove of especial value in the treatment of puerperal infection and of septic abortion due to the latter organism. The results in scattered cases have not been consistently favorable but the general impression exists that if the remedy is started early administered in adequate dosage (3 or 4 tablets 15 to 20 grains three times a day for virulent infections) and continued for sufficient length of time therapeutic improvement will be achieved.

Unfortunately, the remedy is not free of toxic effects. Colebrook² warns of its action upon the blood in certain cases and in a recent contribution Harvey and Janeway¹ point to the development of 3 cases of acute hemolytic anemia. In view of this deleterious side effect the usage of the drug should be reserved for those types of infection in which the action is more or less specific namely for the *Streptococcus haemolyticus* and not employed indiscriminately in all cases of infected abortion. Again the importance of bacteriologic diagnosis is illustrated.

LOCAL MEASURES

Assuming that a proper schedule has been arranged for systemic treatment the problem of management of local lesions sooner or later arises. The answer to it lies in the conditions found upon pelvic examination and upon the degree of advancement of the septic infection. Occasionally the local disturbance is thrust abruptly to the foreground and demands immediate attention. This is the case in vaginal bleeding. The life stream of the patient must be preserved and whatever may be the nature of the other problems in the case vaginal hemorrhage must be arrested. If hemorrhage is the result of placental separation and expulsion and if the products of conception can be felt at the cervical os the best practice is to gently remove them with a curved sponge forceps and to pack the uterus with gauze. This is the best practice for this surgical pro-

Intravenous therapy in 40 000 to 60 000 unit doses is best repeated daily for two to three days or even longer in grave cases in many of less gravity response is so rapid that after the first twenty four hours intramuscular therapy alone is sufficient

Serious cases usually require 200 000 to 600 000 units by combined routes over the course of a few days

It is advisable to err on the side of safety and to discontinue serum only when clinical indications for its usage have been absent for at least two or three days

Such is the state of specific serum therapy in septic abortion There should be a tremendous development in this field within the next generation In the meantime there is enlivening hope in the direction of chemotherapy

CHEMOTHERAPY OF SEPTIC ABORTION

For the past twenty five years scientific medicine stimulated by the brilliant success of the arsenicals in the treatment of syphilis has been toying with the thought of destroying other pathogenic organisms with chemical agents From time to time more or less clumsy manifestations of this idea have appeared First efforts were with the use of certain inorganic chemicals notably the salts of mercury and intravenous injections of bichloride solution were administered with little effect upon the infection and calamitous results to the patient Subsequent developments led to the uniting of metallic substances with various dyes and there appeared less toxic and more efficacious products *e g* mercurochrome and metaphen The latter agents achieved many cures but the failures left much to be desired in therapeutic potency

In 1935 Domagk in Germany inaugurated the clinical employment of a para aminobenzenesulfonamide and its derivatives preparations commonly known as prontosil and prontosil and (in this country) sulfanilamide Favorable reports by Colebrook in England² by Long and Bliss in this country¹⁰

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organisms will be introduced also the cervix must be sufficiently dilated to permit of the removal of products without trauma. Otherwise the operator must resort to the simpler and more readily available procedure of firmly packing the vagina. Here again he must guard against introduction of infection taking time to shave the patient properly prepare the vulva and carefully sterilize his instruments and his hands. Preparations of posterior pituitary extract must be used with caution for too vigorous contractions of the uterus may project bacteria into adjacent lymph spaces and into the blood stream.

While there is little difference of opinion as to the measures necessary in the face of hemorrhage wide divergence of opinion exists as to the time at which the uterus should be evacuated in abortion. In a recent contribution to the Ohio State Medical Journal Herman and Stevenson⁶ present a resume of results obtained with several methods of management (1) noninterference (2) sponge forceps and placenta forceps removal (3) curettement (4) evacuation with later curettement. Upon the basis of their observations they conclude that surgical interference either by sponge forceps evacuation or by curettage results in a definite decrease in morbidity with no increase in mortality and is the immediate treatment in uncomplicated incomplete abortion. In the presence of infection their attitude is more conservative. They go on to say— deaths occurred in those instances in which almost hopeless complications were present at the time of admission. In such cases local measures of any kind were apparently of no avail.

On the other hand Davis in a recent number of the Journal of the Michigan State Medical Society⁷ presents the common attitude of the general surgeon in recommending evacuation of all cases with the sharp curet.

Presumably this attitude is based upon the assumption that diseased and infected tissues such as acutely inflamed appen-

infections of feeble pathogenicity it may prove just the factor which will throw the balance against the patient with serious inflammation whose infection has spread beyond the endo

metrium to vascular and lymphatic tissues where nature is endeavoring to build up a barrier against further progress. It is a wiser plan in such cases to wait with local measures and assist nature in her battle to preserve systemic resistance.

After reviewing the many deaths presented to it each year for study, the Committee on Maternal Welfare of Philadelphia³ feels that a dictum should be laid down in regard to treatment of these cases. In septic or potentially infected abortions the uterus should not be invaded further than to remove material from the cervix for better drainage of the uterine cavity or for the control of hemorrhage.

There appears to be one exception to this plan of conservative management of the local lesion and that is in the instance of infection with the gas bacillus. Those who have had experience with large series of these cases seem to feel that the only hope for the recovery of the patient in well established clinical infection of this type lies in the prompt and complete removal of the infected tissue. Again I quote from the authoritative paper of Arthur Hill.⁵ Success in treatment depends upon the practical application of three cardinal principles: early diagnosis, early elimination of the primary focus, immediate and massive specific and general therapy. He advises early and careful uterine curettage under gas and oxygen anesthesia and in abortal physometra—immediate total hysterectomy with adnexa if necessary.

INCISION AND DRAINAGE

The progress of infection must be closely watched. Systemic response may be estimated by observations of general appearance, temperature, pulse, decrease in the colonies of blood culture and improvement in the blood picture and nuclear shift.

Every third or fourth day the pelvic examination should be repeated. This procedure is essential in order to detect the development of fluid collections of inflammatory exudate. If some such systematic method of observation is not employed the obstetrician may be chagrined to find that his patient ultimately succumbed to an extensive parametrial phlegmon which might have been relieved by incision and drainage. The longer the patient survives the original onslaught of infection

organisms will be introduced, also the cervix must be sufficiently dilated to permit of the removal of products without trauma. Otherwise the operator must resort to the simpler and more readily available procedure of firmly packing the vagina. Here again he must guard against introduction of infection, taking time to shave the patient, properly prepare the vulva and carefully sterilize his instruments and his hands. Preparations of posterior pituitary extract must be used with caution for too vigorous contractions of the uterus may project bacteria into adjacent lymph spaces and into the blood stream.

While there is little difference of opinion as to the measures necessary in the face of hemorrhage, wide divergence of opinion exists as to the time at which the uterus should be evacuated in abortion. In a recent contribution to the Ohio State Medical Journal, Herman and Stevenson⁶ present a resume of results obtained with several methods of management: (1) noninterference, (2) sponge forceps and placenta forceps removal (3) curettement, (4) evacuation, with later curettement. Upon the basis of their observations they conclude that "surgical interference, either by sponge forceps evacuation or by curettage results in a definite decrease in morbidity with no increase in mortality, and is the immediate treatment in uncomplicated incomplete abortion." In the presence of infection their attitude is more conservative. They go on to say—deaths occurred in those instances in which almost hopeless complications were present at the time of admission. In such cases local measures of any kind were apparently of no avail.

On the other hand Davis, in a recent number of the Journal of the Michigan State Medical Society⁷ presents the common attitude of the general surgeon in recommending evacuation of all cases with the sharp curet.

Presumably this attitude is based upon the assumption that diseased and infected tissues such as acutely inflamed appendices and septic abortions should be promptly removed from the body. This conception of abortion does not appeal to the

text of obstetric pathology. While such vigorous treatment of incomplete abortion and may prove just the factor the patient with serious inflammation, whose infection has spread beyond the endo-

SUMMARY

Septic abortion is either potentially or actually a systemic infection. A complete physical examination and thorough laboratory study is necessary to determine the patient's resistance, the degree of advancement of infection, and the local manipulation which may prove necessary.

As a general rule one's attention in therapy is first directed toward systemic and supportive treatment in an effort to nurture those resistant powers with which nature has endowed the human body. Especial importance is attached to rest and an adequate intake of food and fluid.

For very few infections are specific antiserums available—the streptococcus of scarlet fever, the pneumococcus, and the bacillus of Welch. The polyvalent streptococcus antiserum seems to the author to have some value in early and as yet local forms of infection.

Interesting developments are taking place in the field of chemotherapy. The latest addition to this group of remedies, sulfanilamide, appears to have some value in septic infection. Its action appears particularly efficacious in the instance of streptococcal infections of the hemolytic type, and its use had best be limited to this form of infection in view of certain side effects which have recently been pointed out.

Local therapy appears of secondary importance in the treatment of these septic lesions. Hemorrhage may demand immediate attention, and if the products of conception are at the mouth of the womb they should be removed so that blood loss may be arrested. Otherwise attempts to empty the uterus which necessitate trauma should be postponed until the infection is under control.

The patient who is convalescing from septic abortion should be given tonic treatment to restore systemic strength. Local involution may be stimulated by such mild measures as hot douches and oxytocics. Even at this stage curettage is not free of danger.

Throughout the disease the slogan should be: Treat the patient, care for local conditions as they arise.

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particularly if the temperature remains elevated the more likely she is to display localizing signs

These may appear as a girdle of inflammatory products around the uterus pointing anterior or posterior to it. If at a higher level in the pelvis the cellular exudate may point above the groin or at the crest of the ilium. Wait long enough for the accumulation to be accessible and well walled off and then incise freely. If the abscess points at the brim of the pelvis insert split tube drainage. If the posterior cul-de sac must be opened for pelvic abscess the cavity may be packed after evacuation, with gauze—the latter to be removed *in toto* at the conclusion of five or six days. Be on the watch for pyemic manifestations in other parts of the body as well as in the pelvis.

As the symptoms of general infection subside, the patient is left a shadow a ghost of her former self. Tonic measures are in order, provisions for the building up of general nutrition and the reestablishment of normal blood picture. Locally the condition of the pelvis may be not too favorable. Often subinvolution persists and areas of chronic induration of the broad ligaments remain. Involution may be stimulated with tonic doses of such oxytocics as ergot, quinine and strychnine. Hot copious vaginal douches may now be administered twice daily—given slowly with the patient recumbent and hips elevated upon a douche or bed pan. Resistant types of chronic pelvic infection may be relieved by the Elliott treatment or by the judicious use of diathermy.

Caution must be exercised even at this stage in the application of curettage. There are two dangers—perforation and relighting of infection. The edematous wall of the uterus has a feeble resistance like wet blotting paper and the lightest pressure may carry an instrument through it. In the other direction I have seen curettage performed upon a woman three months after induced abortion light up a disturbing infection with rigors and a fever of 103° to 104° F. which continued for three days.

General systemic improvement and regression of local symptoms go hand in hand and little is lost in the following of the rule which seems so important in the management of every stage of septic abortion—treat the patient and care for the local phenomena as they arise.

CLINIC OF DR. EDWARD A. SCHUMANN

KENSINGTON HOSPITAL FOR WOMEN

POSTPARTUM HEMORRHAGE

HEMORRHAGE during the third stage of labor or shortly after its completion, is the most frequent variety of bleeding associated with pregnancy with the exception of that accompanying abortion during the early months of gestation.

As a cause of death, this variety of hemorrhage was responsible for one in every 22 mortalities analyzed by the Committee on Maternal Welfare from 1931 to 1933 inclusive. In addition to the 33 fatalities from this cause among a total of 717 there were 62 deaths in which the records showed there had been severe or more than usual postpartum blood loss. In the same series there were 25 deaths from placenta praevia and 19 from abruptio placentae. These figures show the pre dominance of postpartum hemorrhage as a factor in maternal mortality in the hemorrhage group of diseases.

Analysis of the above series of cases from an etiologic viewpoint corroborates the experience of the writer and others, which has tended to show that the generally stated factor of inertia uteri, while an important cause, is by no means the most common causative agent.

As one reviews one's own cases of the accident, its frequent association with the toxemias of late pregnancy—preeclamptic toxemia and eclampsia itself—stands out sharply. I have come to watch with often justified alarm, the delivery of profoundly toxic women in the anticipation of postpartum hemorrhage. Furthermore since it is true that despite their hypertension and general sthenic condition such toxic women withstand blood loss very badly, a fatal result often occurs under this combination of circumstances, which might readily have been avoided had one of the factors been absent.

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Fibroid tumors of the uterus are not infrequently instrumental in causing postpartum hemorrhage by reason of the fact that the tumor masses, encroaching upon the uterine musculature break the rhythm of contractions and also because submucous fibroids may distend a uterine cavity and prevent its firm contraction. Deep anesthesia particularly with nitrous oxide or chloroform is also a common causative agent and one must be always on guard in such instances for the hemorrhage which may follow.

Hemorrhage due to Trauma—Obviously deep lacerations of the cervix or perineum may be and often are responsible for severe bleeding. Such lesions may be anticipated when hemorrhage is profuse despite the fact that the uterus is firmly contracted.

Blood dyscrasias and what has been termed constitutional inferiority (for lack of a better term) may be responsible for bleeding but quite uncommonly so.

DIAGNOSIS

The diagnosis of postpartum hemorrhage should be a simple matter since the condition simply implies an extensive amount of blood loss during or after the third stage of labor. The average amount of bleeding has been estimated at 250 cc and if this amount be increased to 600 cc or more the condition is termed postpartum hemorrhage. It has been shown that parturient women may survive a blood loss of 3500 cc although such depletion is usually fatal. Many ingenious devices have been perfected for measuring the bleeding after delivery the one developed by Pastore at the New York Lying in Hospital being particularly effective. The hemorrhage may be of two varieties either a violent massive gush of blood immediately following the expulsion of the placenta which continues until stopped by active treatment or there may be a continuous moderate trickling of blood which all too often does not cause alarm until the sudden collapse of the patient calls attention to the great amount of blood which has been lost.

Women who have been delivered should invariably be under close observation for at least an hour after the placenta has been expelled in order to recognize the insidious bleeding of the slow type postpartum hemorrhage.

The physiologic relation between toxemia and hemorrhage has not been explained satisfactorily as yet. Whether the coincident hypertension so increases the force of the blood in the veins and arteries as to inhibit the formation of clots in the torn sinus ends, or whether some other cause is active, is not known.

The point to remember is the clinical association between the two conditions in order that adequate preparations for combating hemorrhage may always be made prior to the delivery of a toxic woman. One must be especially on guard when performing cesarean section in toxemia since uterine hemorrhage occurring sometimes after the completion of the operation proves a most dangerous complication.

ETIOLOGY

Postpartum Hemorrhage due to Inertia Uteri—This is the classical relationship and occurs with sufficient frequency to warrant the fear in which the curious anomaly in function is held. The true cause of inertia uteri is not known although Goodall has advanced an interesting theory involving a disturbance of the autonomic system of the splanchnic area and as the autonomic system is under the control of the endocrine

and the frequent necessity of effecting delivery by operative means.

In *secondary inertia* due to exhaustion of the uterine muscle hemorrhage is also common especially since in such patients difficult operative delivery with deep anesthesia is so often the rule.

Retained Placenta Either Entire or in Part—Partial

readily be noted

resulted in such profound narcosis that often women lay for hours in complete unconsciousness and with an almost complete cessation of labor. When finally this induced uterine inertia resulted in enough contractions to bring about cervical dilation the delivery had of necessity to be secured by operative means usually after the addition of further inhalation anesthesia to further raise the pain threshold. Naturally a uterus subjected to such blocking of nerve impulses lacks the power of contraction which is so vitally necessary during and after the third stage of labor.

The management of the third stage of labor too has an important bearing upon this matter.

Normally immediately upon the birth of the child with the great reduction in volume of the uterine contents this organ begins to contract and its fibers to retract. The uterine muscle consists of a most complex interlacing arrangement of muscle bands which contract in all directions in a rhythmic manner periods of strong contraction alternating with times of quiescence much like the periodicity of labor pains.

The interval between contractions rapidly lessens and after some minutes the placenta having been detached by a diminution of the area of its uterine base is expelled and the muscle fibers retract and remain in almost continuous tense contraction. If the rhythm of this mechanism be disturbed by undue efforts at hastening it by fundal massage traction upon the cord etc. the continuity of the process is thrown off balance and failure of contraction may result. Furthermore premature efforts at detachment of the placenta before the muscle fibers have had time to undergo their periodic contractions and so reduce the size of the uterus often results in gaping vessel mouths and consequent hemorrhage.

Among women who have had no anesthesia whatever it is well known that postpartum hemorrhage is fairly uncommon especially so if the natural processes of adjustment and physiologic retraction and contraction of the uterus be not disturbed.

Unfortunately it is often necessary to hasten and aid this process after operative deliveries or in cases in which the woman is unable to utilize the secondary forces of the abdominal walls to further placental separation and expulsion and in such instances the hypodermic administration of pituitrin

TREATMENT

The management of postpartum hemorrhage divides itself naturally into prophylactic and active measures

An important aspect of prevention is the physical condition of the woman approaching term. The anemia so common in pregnancy should never be permitted to become severe and periodic blood counts with the free use of hematinics such as iron salts with the addition of liver and stomach extract, if necessary, will prevent many hemorrhages.

During the last weeks the pregnant woman should be advised to rest abundantly and to minimize her household duties in so far as practicable, in order that she may approach the violent exertion of parturition with her physical forces unimpaired.

The time-honored practice of limiting the protein intake during the last trimester with the special restriction on the ingestion of meat is erroneous since it has been abundantly

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During labor the excessive use of anesthetics and analgesics is a prime factor in the causation of bleeding after delivery. Chloroform and nitrous oxide are notable offenders and while their employment is often indicated the anesthesia should always be as light as possible under the particular circumstances. Many clinicians have noted that after prolonged and deep analgesia with the barbiturates or opium derivatives the contractile power of the uterine muscle is sharply inhibited and as a consequence the sinuses are not compressed after expulsion of the placenta with resulting bleeding of more or less severity.

I have on many occasions deplored the excessive use of analgesics and anesthetics not only in obstetric practice but in gynecologic surgery where experience has convinced me that patients often suffer more danger in their attempt to eliminate toxic drugs and in the depression that follows their employment than from the traumatism of the operation or labor itself.

As regards analgesics the wave for complete amnesia which recently swept the country and which is now happily receding

active treatment was not begun until the blood loss became alarming. In a number of these cases the committee felt that more prompt and energetic measures might have prevented the fatal termination.

In this connection it must be remembered that parturient women often withstand a considerable degree of hemorrhage without systemic change but suddenly the anemia becomes acute and collapse, air hunger and cardiac failure supervene. Therefore one should not pursue a policy of watchful expectancy in the management of postpartum hemorrhage but vigorous treatment should be instituted as soon as it becomes evident that the hemorrhage is excessive in amount.

Packing—Gauze packing the strips being 4 inches wide and 4 yards long made of 4 thicknesses of gauze with the selvage turned in, is the first line of defense against postpartum hemorrhage. Such packing sterilized and contained in large glass tubes jars or cans should be a part of the armamentarium of every obstetrician either for home delivery or in hospital.

Whenever pituitrin and ergot given immediately after the completion of the third stage of labor fail to control the bleeding the uterus should be firmly packed from fundus to cervix the packing held in place by a firm vaginal tamponade of the same material.

Many men hesitate to pack the uterus except under stress of dire necessity, fearing infection. In my own experience I have very rarely noted any ill effects from this procedure and may say that while I have never regretted employing it I have often wished I had done so more promptly.

Uterine packing is a formal procedure to be performed with an aseptic and most careful technic. If at home the patient should be drawn across the bed buttocks resting on the edge of the mattress if in hospital the work should be done on the delivery table.

If the patient is incooperative and reacts easily to pain a light anesthesia may be necessary but this is rarely the case.

With the patient in the lithotomy position the legs either held in stirrups or supported by attendants the entire pudendal region is meticulously scrubbed as though for delivery. After draping the operator aseptic and gloved introduces a hand into the uterus and explores its cavity seeking retained

in generous dose ($\frac{1}{2}$ to 1 cc) immediately after the birth of the baby is an excellent adjuvant

The too common practice of having a nurse or assistant clutch the uterus the moment the child is born and squeeze it violently in an effort to detach the placenta is mentioned only to be condemned. It is not necessary to touch the uterus in the third stage of labor except when the patient is deeply anesthetized or in the presence of free bleeding.

As soon as the placenta is detached uterine contraction may be greatly aided by the administration of ergot preferably the newly isolated substance, ergonovine. Unfortunately this material had been developed by several manufacturers before it received its official designation and consequently the obstetrician has a choice of several trade named products all of which owe their activity to ergonovine. The work of Adair and others has proved the increased oxytocic activity of this drug and its effect upon the parturient uterus. Contraction is rapid and the entire organ becomes firm and hard retaining this consistency for some hours.

It has been shown that ergonovine does not cause marked contraction of the cervix so that theoretically it may be administered before the expulsion of the placenta without danger of imprisoning this structure but from the intensity of the observed contraction I have feared this accident and accordingly utilize the older preparations before the placenta is born giving ergonovine immediately after.

Beecham in this clinic has shown that the continued administration of ergonovine for three or four days after delivery markedly reduces the period of sanguineous lochia as well as maintains the uterus in firm contraction. Its use in this manner is advised.

ACTIVE TREATMENT OF POSTPARTUM HEMORRHAGE

The immediate management of bleeding after delivery may be summed up in three words—haste packing transfusion.

The necessity for haste is demonstrated by the fact that in the fatal cases of postpartum hemorrhage studied by the Philadelphia County Medical Society's Committee on Maternal Welfare the average time interval between the beginning of the bleeding and death was five hours. In most of these cases

active treatment was not begun until the blood loss became alarming. In a number of these cases the committee felt that more prompt and energetic measures might have prevented the fatal termination.

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portions of placenta, possible rupture of the uterus and in the process, removing all blood clots

The hand is then withdrawn and reenters the uterus with the end of the strip of packing held in the fingers. The tube or jar container is placed close to the buttocks so that the gauze will flow freely from its mouth and the uterus is gently but firmly packed with the hand. An assistant palpating the fundus through the abdominal wall and holding it steady, is a valuable aid but this is not essential.

When the uterus is firmly packed the end of the gauze is allowed to protrude from the vulva and is cut off. Another firm pack is then inserted into the vagina, filling this cavity. A tight abdominal binder to which is attached a T bandage completes the operation. Some obstetricians prefer to use dressing forceps or a Holmes packer but in my own experience nothing is so satisfactory as the hand. The patient is then returned to bed, the foot elevated and external heat applied. In certain severe cases there is a leakage of blood through the packing within an hour or so and in such instances the pack should be withdrawn and the entire process repeated. At this time a hot uterine douche of sterile water possibly fortified with a mild antiseptic and of a temperature of 110° to 112° F is often of great value both in stimulating the uterus to contraction and in washing away accumulation of blood clots.

The packing may be removed safely in twenty four hours in most cases preparation being made to repack if necessary as is very infrequently the case.

Transfusion and Fluid Replacement—As soon as may be, coincidently with the packing if possible the woman is given fluids intravenously. Blood of course is the choice but in home deliveries and even in hospitals with small house staffs some delay unavoidably occurs while donors are being assembled bloods matched and typed and the like. During the interval glucose in 10 per cent solution, gum acacia solution or lacking these normal saline may be given in sufficient amount to supply the fluid loss 1000 cc being a standard dosage—more if necessary.

Every effort must be made to secure blood for transfusion and the obstetrician confronted with this perilous complication of labor during a home delivery should at once summon skilled

and abundant help to assist in the various measures demanded if a life is to be saved

The importance of prompt transfusion cannot be overestimated and the favorable results of this procedure are in almost direct ratio to the time interval between the blood loss and its replacement

Other Measures to Control Postpartum Hemorrhage

—The discovery of and prompt repair of laceration of cervix and perineum which may cause serious hemorrhage is so obvious a matter that it requires but little comment. Observation of the cervix either with a speculum or by utilizing the finger to distend the vagina and expose the cervix to view will at once disclose a bleeding vessel as will a scrutiny of the pelvic floor. Simple ligation of the bleeding point or a formal repair of the laceration will at once stop the bleeding.

Sewing the cervix shut over packing has been practiced but I have had no experience with this procedure. Occasionally in extremely resistant cases hysterectomy must be performed when all other measures fail. This is a desperate remedy for desperate situations and all too often results in disaster the already exsanguinated woman being unable to withstand the shock and trauma of a major abdominal operation. However this procedure has its place but certainly a small one.

It has been proposed to clamp or ligate the uterine arteries via the vaginal vault as in the initial steps of a vaginal hysterectomy. In the hands of a trained operator this plan offers certain attractions but I have never had occasion to employ it and cannot speak from experience.

The use of Momberg's band which is a tourniquet applied around the body and tightened to a degree sufficient to compress the aorta seems impracticable to me and is not advised.

The after care of patients who have suffered from severe postpartum hemorrhage consists in frequently repeated blood transfusions, generous feedings, maintenance of body heat, hematinics and sunshine. The administration of ergonovine in some form should be continued for several days.

If one were to summarize the management of this dangerous and common complication of childbirth the words which opened this discussion of active treatment might well be repeated—haste, packing and transfusion.

CLINIC OF DRS CHEVALIER JACKSON AND CHEVALIER L JACKSON

TEMPLE UNIVERSITY HOSPITAL

CANCER OF THE LARYNX

CANCER of the larynx is curable in 82 per cent of the cases as clearly demonstrated by our statistics yet gross statistics show that 90 per cent of the patients with cancer of the larynx die of the disease

The reason for this apparent paradox is that most of the patients do not come in for treatment in the potentially curable stage of the disease. Of the last 200 patients that came to this clinic with cancer of the larynx only 38 came in the curable stage. The chief reason for this deplorable state of affairs is that the frequently malignant nature of chronic hoarseness is not generally recognized.

We shall consider 3 cases illustrative of the subject of cancer of the larynx.

Case 1—A man sixty years of age gives a history of hoarseness of two years duration. At first it was intermittent but recently it has been quite constant. There is slight dyspnea and wheezing on exertion. The patient dates all his trouble from an acute laryngitis accompanying an attack of the grippe six months ago but close questioning reveals the fact

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Examination with the laryngeal mirror shows a fungating ulcerative lesion on the left side of the larynx.

Palpation reveals no gross adenopathy, but there is a suspicious sensation on deep palpation under the left sternocleidomastoid muscle. On careful palpation we find decided

evidence of thickening and slight convexity of the usually flat or slightly concave thyroid cartilage. This convexity is on the left side and is noted particularly in contrast to the right side which seems normal. The patient admits that the convexity is tender when we press upon it.

The patient having been sent out we may consider the question

What are the diagnostic possibilities?

One thing is certain from palpation, that thickened tender

lymphatic node

We have here a fungating ulcerative lesion. In 99 per cent of the cases such lesions are in one or more of three groups, cancer, syphilis, tuberculosis.

How shall we differentiate them?

They can always be differentiated easily, quickly and conclusively by biopsy. There are certain diagnostic steps, however, that should be taken first and these should be done by the family physician or under his supervision. The two things are the determination as to the existence of active tuberculosis and latent syphilis. When this patient came we inquired of the family physician as to these possibilities. He said in effect that he had known the patient all his life and was sure there was nothing of this kind to be considered. We were not surprised to find a strongly positive serologic reaction denoting systemic syphilis. This does not mean that the laryngeal lesion is necessarily syphilitic but it always calls for postponement of biopsy until a course of antisyphilitic treatment has been given.

In this case we have uncovered several phases that are important from the point of view of general practice.

First when a patient is hoarse we should always think of cancer, tuberculosis and syphilis and we must not rest until the differentiation has been made. The sooner it is made the better.

Second when a man is hoarse the larynx should be carefully palpated externally. It is very well to feel for lymph nodes but the palpation of Adam's apple should never be

neglected. If we find swelling and tenderness of the thyroid or cricoid cartilages perichondritis is probably present, but we must not stop our diagnostic researches there. Perichondritis is usually secondary to cancer, syphilis or tuberculosis. All other possibilities are exceedingly rare and are not to be considered unless the big three are definitely decided in the negative after use of every diagnostic means we possess.

Third when an adult patient comes in with hoarseness cancer should be suspected, but in such cases syphilis and tuberculosis are first to be excluded and this is best done by the family physician.

Fourth under these circumstances the family physician should not rely upon accumulated knowledge of the patient's medical history but should make a thorough examination. As in this case, the patient may have gone elsewhere for the treatment of a venereal infection.

Case II—This patient is about to be discharged. He was sent in for laryngectomy because of a supposed cancer of the larynx. He had and still has an extensive fungating ulcerative lesion involving the right cord. We did not do a laryngectomy because biopsy demonstrated the lesion to be tuberculous. Our colleagues in the Department of Diseases of the Chest have demonstrated the presence of a nonaggressive but unmistakable pulmonary tuberculosis. This alone would not be conclusive evidence that the laryngeal lesion is tuberculous; there would be no certainty that carcinoma was not present as the sole or part of a mixed lesion. But the existence of the pulmonary tuberculosis corroborates the histologic diagnosis of laryngeal tuberculosis, and, most important, it constitutes the basis for treatment. This patient is going to a sanatorium where he will be put upon a strict antituberculous regime including twenty hours out of each twenty four of rest in bed outdoors or under outdoor conditions. The only laryngeal treatment indicated in this case is a regime of silence, the patient writing everything he has to say except for about 20 words a day spoken in a low tone to his medical attendant, by way of a little gentle motion for his arytenoids. If the pulmonary lesion gets well the laryngeal lesion will also.

This case illustrates the importance of biopsy in cases of

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neck and gastrostomy for feeding through the abdominal wall will be necessary if radiation is not employed, and may become necessary in case of recurrence

This is a sad picture But we must not tell the patient of the depressing outlook It would be cruel to do so Nothing is more certain than that a hopeless outlook shortens life and makes the remaining days miserable We shall tell the patient that radiation is preferable to operation in her case and that is true

The most important as well as the saddest feature of this case is that this young woman is almost certainly doomed to an early death She now has perhaps, a 10 per cent chance of recovery whereas had a diagnosis been made in the curable stage she would have had an 82 per cent chance of cure by the relatively minor operation of laryngofissure

Why was the potentially life saving opportunity lost?

Because during the curable stage of cancer she was treated for chronic laryngitis on an inferential diagnosis without a laryngeal examination

It is very unusual to see carcinoma in a woman and it is also unusual to see laryngeal carcinoma in man or woman so early in life as thirty six years

But it is not unusual to see a patient treated under a mistaken diagnosis of chronic laryngitis until the real lesion, a cancer, has become hopelessly incurable It is a sad commentary, but only too true that this deplorable calamity is relatively common

In conclusion permit us to say that we have shown you 3 cases of laryngeal disease one each of cancer, tuberculosis and syphilis These are the diseases that the practitioner should think of first in all cases of hoarseness in adults because all are curable if the diagnosis be made early

suspected malignant disease of the larynx. To have removed this man's larynx without histologic examination of a specimen of tissue would have been an awful mistake. Yet during the recently fashionable advocacy of extirpation of cancer without biopsy the larynx did not escape. Possibly the taking of a specimen in case of mammary cancer may risk dissemination but because of the very peculiar lymphatic arrangement in the larynx there certainly is no such risk. Moreover the loss of a mamma in a patient of cancerous age is no great disaster whereas the needless removal of the larynx is a catastrophe no surgeon would risk having on his conscience.

Case III—This woman, aged thirty six years, gives a history of intermittent hoarseness during a period of two years. On palpation of Adam's apple we find the thyroid cartilage enlarged and tender on the right side. On deep pressure underneath the right sternomastoid muscle we find a small hard lymph node. Examination with the laryngeal mirror shows the right side of the larynx is filled with an ulcerative fungating lesion.

Having sent the patient out we may freely discuss the case.

She had been treated for chronic laryngitis during a period of nearly two years by one practitioner after another, 6 in all, before coming under the care of the physician who sent her in promptly with a tentative diagnosis of cancer of the larynx. He had already excluded syphilis and tuberculosis. We took a specimen of tissue and the report has just been received: the growth is a squamous celled carcinoma grade 4.

It remains only to discuss treatment and prognosis.

Operation is contraindicated because the disease is extrinsic and has invaded the base of the tongue near the base of the epiglottis. Additionally the cancerous process is a very aggressive type, grade 4 histologically. A third point is that there is adenopathy. Operation no matter how radical is utterly hopeless. Not only is the operative mortality high but the growth is certain to recur.

On the other hand radiation using a Coutard series of roentgen ray treatments will arrest the growth for a time and may offer as much as a 10 per cent chance of freedom from recurrence. Palliative tracheotomy for breathing through the

CLINIC OF DR. GEORGE M. DORRANCE

UNIVERSITY OF PENNSYLVANIA

ACUTE INFECTIONS OF THE SOFT TISSUES OF THE NECK

THE neck is composed of the structures lying between the plane determined by the base of the skull and the lower margin of the jaw and by the first ribs.

While some of the infections of the throat and soft tissues of the neck are purely local in origin many are the result of infections elsewhere in the body.

Superficial infections of the skin and subcutaneous tissues such as furuncles and carbuncles are important sources of suppurative processes in the deeper glands. Erysipelas with its red flush and raised irregular borders enclosing islands of normal skin and occasionally blisters should be recognized on sight in order that the effective treatment by x ray should be instituted promptly. Anthrax, actinomycosis, blastomycosis, lupus and syphilis are mentioned to remind us to keep them in mind in making a diagnosis. In these local infections accurate diagnosis is essential before treatment is undertaken. In the region of the nape of the neck the skin is much thicker and much more closely adherent to the fascia and is poorly supplied with blood. Hair follicles and sebaceous cysts are numerous. This area is constantly exposed to minor traumatism and changes in surface temperature. For these reasons furuncles and carbuncles are especially common in this area and are apt to be exceptionally painful. Immediate treatment with x ray has proved almost a specific in the relief of pain and control of the infection. If suppuration occurs the pus must be evacuated. In all cases of carbuncles and persistent furuncles repeated blood sugars must be taken. If the blood sugar is above normal appropriate treatment should be given even though

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true diabetes does not exist, a diabetic regime should be instituted until the infection subsides. It is necessary to warn these patients to have their blood sugar taken after recovery at certain intervals in order to keep it within the normal limits as a prophylactic measure against recurrent attacks.

To understand the conduct and modes of extension of acute infections in any part of the body, it is essential to note not only the origin of the infections and the character of the invading organisms, but also the peculiarities of the anatomic structure of the parts invaded. This is particularly true in suppurative processes of the neck where deeply situated pus frequently presents a difficult diagnostic problem.

The importance of the cervical fascia in limiting and directing the spread of pus has long been recognized. Undoubtedly, infection has a definite origin and spreads along routes determined by the anatomic architecture of the part. Surgeons as a whole agree with Havens that "pus does not burrow along fascial lines as frequently as the anatomist would have you believe." This impression may arise from the fact that the surgeons see patients only after the infection has broken through the anatomic barriers.

The space between the superficial and middle layers of fascia does not exist in fact and has no surgical significance below the level of the hyoid bone. Theoretically, an infection in this space could spread into the superior mediastinum but it would be more likely to point superficially since the fascia in front of it is very thin.

The visceral space between the middle and deep layers of fascia contains all the principal structures of the neck. As it communicates directly with the superior mediastinum and the axilla, infection within this space may readily spread in these areas. Above the hyoid bone the fasciae of the neck form their most important lines of cleavage.

The superficial cervical muscular fascia which encloses the

The fused fascia ascends to the lower border of the mandible where it divides into a superficial and a deep layer. The superficial layer attaches to the periosteum and also covers the

masseter muscle. It next covers the parotid gland after which it fuses with the temporal fascia. The deeper division likewise reinforces the periosteum of the mandible and ascends upward to surround the internal and external pterygoid muscles forming their fascial coverings.

Above the hyoid bone are thus created several important closed spaces in which suppurative processes are most commonly encountered. These spaces are the submaxillary fossa, the space of the parotid gland and the space of the mandible. An additional important space is created between a deep process of the middle fascia and the deep prevertebral fascia known in this situation as the buccopharyngeal fascia. This space known as the lateral pharyngeal space is important in deep upper cervical infections.

Infection of the Lateral Pharyngeal Space—The lateral pharyngeal space is intimately associated with the pharynx, tonsil, parotid and submaxillary spaces. It is pyramidal in shape with a base nearly an inch square at the base of the skull and an apex at the greater cornu of the hyoid bone. Laterally it is bounded by the parotid gland. Medially the superior constrictor muscle separates it from the pharynx and tonsil. Its anterior wall is the internal pterygoid muscle and posteriorly the stylopharyngeal muscle and aponeurosis separate it from the carotid artery and internal jugular vein.

Distention of the lateral pharyngeal space produces bulging of the lateral pharyngeal wall carrying the tonsil with it. Lateral pointing produces lateral displacement of the parotid gland and swelling of the side of the face and neck. Infection within the space is separated from the carotid sheath by the stylopharyngeal aponeurosis. Infection may reach the internal jugular vein by following the smaller veins which empty into it.

The space may be further affected by the fact that an elbow of the submaxillary gland projects between the internal pterygoid muscle and hypoglossus and contacts the lateral pharyngeal space. The most common abscess involving the lateral pharyngeal space is the peritonsillar abscess—quinsy. Following a streptococcic tonsillitis quinsy is ushered in by a chill, rise in temperature and severe pain behind the angle of the jaw. The tonsil is found projecting toward the middle

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The fascial investment of the outer surface of the parotid gland is dense and resistant, the inner layer is thin and weak with a gap existing between the styloid process and the internal pterygoid muscle. Infection within the parotid gland therefore may extend without much difficulty into the submaxillary fossa and into the retropharyngeal space. The routes are reversible in infecting the glands. A peritonsillar abscess may point in the lateral pharyngeal space and thus infect the parotid. Infection of the face may spread along the parotid duct. Ear infection may pass along the lymphatics through Santorini's fissure to reach the parotid. The gland may also be infected, of course, as a consequence of recurrent obstruction of Stensen's duct. Parotitis seems to occur spontaneously following operations and there is no unanimity of opinion concerning those cases which occur postoperatively. Most surgeons believe that the infection originates in the mouth and is carried through Stensen's duct to the gland in the majority of cases. In some cases it is hematogenous in origin. It most commonly occurs following operations on the abdomen or genito urinary tract and in patients who are seriously ill, in poor general condition, undernourished, dehydrated, and show poor oral hygiene. The dry mouth seems to be a frequent precursor of parotitis. Curiously enough it is not so common after operation within the mouth as after abdominal operations. It is interesting to note that even after local or spinal anesthesia parotitis may occur. Dr Babcock in a personal communication states it occurs as often after spinal as ether anesthesia.

The signs of parotitis are painful swelling of one or both sides of the face, as in mumps. Serum or pus can frequently be expressed from the duct.

In the treatment of this particular infection x ray or radium has given dramatic results. Incision and drainage is becoming constantly less frequent. Daily dilation of Stensen's duct has been advocated by many surgeons.

Occasionally subacute or chronic inflammation of the parotid follows acute infections. At the American Oncologic Hospital we see a considerable number of parotid swellings due to inflammation. These cases are sent to us as parotid tumors.

of the fauces. The mucous membrane covering the pillars of the fauces and soft palate is intensely red and the uvula is edematous. The condition demands early incision and drainage.

The site of election for opening a peritonsillar tonsil abscess is 1 cm. above the anterior faucial pillar. After cutting through the mucous membrane spread the incision with a hemostat after the method of Hilton. Ten per cent cocaine will, if applied for two minutes to the area, give sufficient anesthesia.

Inasmuch as infection of the lateral pharyngeal space extends in a vertical direction from the base of the skull to the greater cornu of the hyoid bone and often lower, it is occasionally necessary to drain the space externally. Dean describes the best external approach. A vertical incision is made in the infrahyoid region along the anterior border of the sternomastoid muscle to the level of the cricoid. Incision is made through the skin and superficial fascia only. Blunt dissection is employed until the space is reached; the opening may be enlarged upward and downward if necessary.

Retropharyngeal Space—The retropharyngeal space is bounded anteriorly by the buccopharyngeal fascia and posteriorly by the prevertebral fascia.

Retropharyngeal Abscess—Pus which tends to point in the pharynx may arise from the pus breaking through from the buccopharyngeal space mentioned above; it may arise from lymphatic nodes in the retropharyngeal space or from caries of the vertebrae.

Treatment—With the exception of the tuberculous abscess which should never be opened through the pharyngeal wall even when mixed infection is present, all other abscesses should be drained by an incision in the pharyngeal wall of sufficient

be done

Infection of the Parotid Space—Acute parotitis may be simple or epidemic, pyogenic or suppurative. Mumps is a simple epidemic self-limited infection whose description need not be detailed here.

Pyogenic or suppurative parotitis is a serious infection and is often a complication of suppuration elsewhere.

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With the modern refinements of diagnosis including lipiodol injections of the ducts accurate diagnosis of all parotid enlargements can usually be made. Years ago we treated infections by milking the ducts and draining the gland by Hilton's method. Recurrence was common and we were not always successful in avoiding the fascial nerve. Surgery was of little value except in the presence of extensive abscess formation. Today, treatments by x ray and radium have made incision and drainage comparatively a rare necessity.

Infection of the Space of the Body of the Mandible — Inferiorly and externally the body of the mandible is reinforced by the superficial fascia and muscle insertions while on the free buccal surface it is covered by mucous membrane.

Infection of the body of the mandible may therefore be prone to discharge into the mouth but it may point externally into the submaxillary fossa or involve the sublingual and submental muscular tissues.

Infection gains access to the body of the mandible through a dead tooth with an alveolar abscess. This may result directly in an osteomyelitis of the jaw or the infection may break through the thin wall of the tooth socket and produce a subperiosteal abscess.

When a tooth with an acute apical abscess is extracted three possibilities may occur. The abscess may drain from the socket and the condition clear up. The pus may find its way into new channels opened by the extraction directly into the bone producing an osteomyelitis or the pus may break through the thin wall of the tooth socket and lie under the periosteum forming a subperiosteal abscess.

The two latter conditions unless recognized early will invariably progress and involve the surrounding soft tissues and the submaxillary lymph nodes.

A careful history will prevent the surgeon directing his treatment to the results of the infection instead of to the source.

Since many of these cases present themselves at the clinic with incision and drainage of the submaxillary spaces I feel the treatment of the acute apical abscessed tooth should be included in a discussion of infections of the neck.

I have no quarrel with the dentist who advocates removing

a tooth in the presence of the so called gum boil or with the one who advises local applications and drainage of the abscess prior to the removal of the tooth but I have a definite antagonistic feeling toward any dentist or surgeon who treats these cases without knowing the pathology present

When a patient presents himself with an acute apical abscess with localized bulging of the periosteum the first and only treatment would be the releasing of this pressure by incision and drainage. If the tooth is loose or becomes loose and can be removed easily—extract it

The incision made under local anesthesia should be sufficiently free to provide adequate drainage

Failure to recognize the significance of the periosteal abscess has led to the complete loss of the mandible in many cases

Scarcely a year passes that I have not seen in consultation 2 or more cases where a sequestrum varying from 2 inches to the entire half of the mandible has resulted from failure to properly diagnose and treat a periosteal abscess

We are not interested here in a full discussion of osteomyelitis of the mandible and the various etiologic factors causing same but are limiting ourselves to the acute apical abscess alone as the common offender which can and should be eliminated as a cause of this condition

Fortunately nature comes to the rescue in many cases causing a spontaneous rupture of the periosteum and evacuation of the pus before much of the bone has been denuded of its periosteum

If the periosteum is not destroyed even though most of the mandible is lost regeneration is the rule

Infection of the Submaxillary Space—Infection gains access to the submaxillary space from an alveolar abscess from the soft tissues of the mouth from the lateral pharyngeal space or by way of the digastric muscles from a focus of infection in the middle ear. Having established a suppurative process in this space closed as it is by dense fascial walls the products of infection find a line of least resistance backward beneath the mylohyoid toward the base of the tongue involving the cellular tissue about the glottis and along the vessels which perforate the fascia frequently producing venous thrombosis. Infection may extend into the parotid gland and the retropharyngeal space

Aside from the cases in which submaxillary infection involves the tissues of the tongue and produces anginal symptoms, there should be no confusion with true Ludwig's angina. Submaxillary infection is unilateral but may be so massive as to mask the original site of infection. X-ray treatment is again the most potent weapon we possess in aborting and limiting the extent of submaxillary infections. When fluctuation occurs the proper procedure is incision and drainage.

Ludwig's Angina—A phlegmonous cellulitis of the floor of the mouth, Ludwig's angina has been confused with submaxillary infections. Because submaxillary space infection occasionally involves the posterior tissues of the tongue and produces edema of the glottis an isolated abscess of the base of the tongue although an uncommon occurrence may also produce the symptoms of angina. According to the newer definitions neither of the two processes is true Ludwig's angina.

Infections arising on the inner aspect of the lower lip the gingival tissues of the floor of the mouth may pass along the lymphatics to the spaces lying above and below the geniohyoid muscles. The superficial space lies between the genioglossus and the geniohyoid. It is bound laterally by the body of the mandible and is divided into two compartments by the median fascial septum. The deeper space between the genioglossus and the mucous membrane contains the sublingual gland. Infection of this space finds ready exit into the mouth. Infection in the superficial muscular space between the geniohyoid and the genioglossus is in the strictest sense of the word Ludwig's angina.

Clinically we are not able to make such a definite distinction. True Ludwig's angina runs a rapid course. In less than eight to ten hours a comparatively minor swelling of the neck becomes a serious surgical problem with a grave outlook.

The patient first complains of pain in the jaw or neck. He has chills. He looks sick from the onset. The swelling becomes boardlike and involves the sublingual and submental areas. There is never any fluctuation. The tongue is pushed upward and backward causing respiratory embarrassment which is further accentuated by the edema of the glottis. There is a whitish membranous exudate under the tongue and floor of the mouth. There is stony like hardness of the floor. The pa-

tient holds the mouth open and complains of pain on swallowing. The pulse is rapid and thready though the temperature may be only slightly elevated or it may suddenly rise and then be followed by a chill.

The infecting organisms are anaerobic streptococci hemolytic in type and frequently are gas producers.

Treatment—x Ray 5 per cent erythema dose followed by wide incisions: the first a midline incision from the tip of the chin to the hyoid bone and from the hyoid bone another incision directed outward under the angle of the jaw to the end of the indurated area. Both incisions are carried through the deep fascia. The tissues cut as if they were frozen; the wound gapes and the cut surfaces have the appearance of liver tissue; gas may escape and the discharge is serous but never puslike in character. As a rule there is a foul odor present. If there is any induration of the floor of the mouth the mylohyoid and the anterior belly of the digastric are divided; if the other side of the neck is involved the same procedure is carried out on that side. In some cases tracheotomy must be performed to prevent suffocation.

Systemic treatment in the form of glucose 10 per cent intravenously or transfusions of blood (250 cc) should be given immediately before, during or just after operation.

The dead space between the

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From the anatomic point of view it is readily seen that the tissues of the floor of the mouth may be readily infected by dental infections. A mandibular root abscess may perforate the shell of bone over the tooth. Suppurative materials may follow the mandibular canal, find an exit at the inferior dental foramen and pass down the mylohyoid groove beneath the periosteum to the sublingual tissues. I have also seen it following injury to the floor of the mouth and with fractures of the mandible. Considering the many possibilities for infection reaching this area it is surprising that Ludwig's angina does not occur more often. We see therefore that the fascias of the neck are not so important in directing the spread of infection as they are in creating dead spaces where infection may settle and develop into massive suppurative processes. The

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infectious process epidemic in nature which affects the cervical glands early in its course and then extends to the intra abdominal glands and to the spleen

The acute symptoms subside in about a week or ten days and the glands are rarely palpable in the course of a month. It is mentioned so one may have it in mind before concluding that one is dealing with an adenitis from infected tonsils etc

Acute Thyroiditis—An acute thyroiditis is due to bacterial invasion of the glands and is comparatively rare. It may develop in a normal thyroid but is more likely to occur in a gland the site of a goiter

Infection is usually hematogenous in origin but may result from direct extension from neighboring structures or by a penetrating wound

At onset there is malaise fever and rigor pain is felt in the neck and is accentuated by swallowing or pressing over the gland. Constitutional effects are often severe and delirium is frequently present. If the swelling is marked hoarseness and cough followed by difficulty in swallowing soon manifest themselves. While it usually subsides with local treatment and brief x ray exposures abscess may form and unless it is promptly recognized and drained it may rupture into the trachea esophagus or the mediastinum

The keynote of treatment of infections of the soft tissues of the neck is correct diagnosis

The roentgen ray has proved of such definite value that it should be our first thought. Results are outstanding in furuncles carbuncles particularly carbuncles of the face parotitis erysipelas cellulitis lymphangitis and adenitis. Treatment in the early stages allows many infections to subside without suppuration. Pain disappears rapidly. Roentgen ray therapy should entirely replace poulticing

The rules governing the use of x ray are definite. We secure our most satisfactory results by the use of light dosage. Five per cent of an erythema dose with low voltage (100 kilo volts) and filtration with from 1 to 4 mm of aluminum is often sufficient to abort a superficial infection and rarely needs to be repeated more than once or twice

We wish to record here that x ray treatments should be given by a competent roentgenologist but the patient should

most important of these spaces are located above the level of the hyoid bone

Lymphatics of the Neck—Since the lymphatics of the neck are always involved in infections of the head, a knowledge of the parts which various chains of neck glands drain is a valuable adjunct to the surgeon in locating the original form of infection in cases presenting no other obvious pathology

The lymphatics of the neck are both superficial and deep, the former nodes communicating with the latter. They are divided into two sets: (1) Transverse which includes the submental, submaxillary, superficial, upper cervical, posterior, auricular, and the occipital. (2) Longitudinal. This group consists of the nodes following the great vessels, viz., the anterior cervicals and the posterior cervicals.

The submental drain the lower lip, the chin, and anterior part of the floor of the mouth.

The submaxillary drain the lips, nose, floor of the mouth, gums, anterior portion of the tongue and side of the face. The superficial upper cervical chain drain the area of the scalp behind and above the ear. The superficial occipital when enlarged should make one suspect syphilis.

The anterior cervical nodes and posterior cervical may become enlarged following the enlargement of any of the above mentioned sets as they are in direct communication with them. They are frequently enlarged from tuberculosis and carcinoma involving the structures of the head or neck.

Lymphangitis—Infectious process anywhere in the head and neck may cause inflammatory reactions in the cervical lymphatic vessels.

The degree of inflammation depends upon the virulence of the organism present and the resistance of the patient. When the original focus of infection is found and cured the inflammation of the lymphatics disappears.

At times a frank abscess may develop following a perilymphangitis and must be drained. This however occurs rarely.

We have found x ray over these inflamed glands a valuable adjunct in restoring them to normal after treating the original focus of infection.

Infectious mononucleosis (Pfeiffer's disease) is a specific

infectious process epidemic in nature which affects the cervical glands early in its course and then extends to the intra abdominal glands and to the spleen

The acute symptoms subside in about a week or ten days and the glands are rarely palpable in the course of a month. It is mentioned so one may have it in mind before concluding that one is dealing with an adenitis from infected tonsils etc

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We wish to record here that x ray treatments should be given by a competent roentgenologist but the patient should

remain under the care of the surgeon, as surgical intervention may become necessary at any time In no place in the body is more judgment needed to know when and where to operate

When pus is present as indicated by fluctuations, it must be drained and supportive treatment to the patient must be employed

CLINIC OF DRS HARRY E BACON AND
THEODORE F REUTHER

FROM THE PROCTOLOGIC DEPARTMENTS OF THE GRADUATE AND
TEMPLE UNIVERSITY HOSPITALS

WOUNDS OF THE ANORECTUM AND THEIR TREATMENT

Wounds involving the anorectal region are either traumatic or surgical in origin. Because the latter predominate and can in general be controlled a consideration of such wounds their types extent, after care methods of and periods for healing, possible contaminations and complications, and the consequences to the patient, is essential to the surgeon and will be of use to the general practitioner who may be called upon for the after treatment of such cases.

TRAUMATIC WOUNDS

Traumatic wounds of the anorectum may be classified in their general divisions as burns abrasions lacerations, puncture perforation and rupture. The most frequent cause of burns would be the use of local applications which are too hot, or enemas or any other injections, especially oil, of too high a temperature. Also to be mentioned are those resulting from the use of x ray and radium. Abrasions, lacerations, puncture, perforation, rupture may result from any of the following causes.

1 Foreign Bodies —(a) Swallowed as pins, tacks, coins, false teeth glass fruit stones, etc. When objects such as these pass through the gastro intestinal tract, a frequent site of lodgment is the sigmoid or rectum, with its convolutions and pockets. Such stasis may result in pricking or puncture from sharp objects, abrasion or laceration from the movement of rough surface or large objects, abscesses from inflammation or rupture from prolonged pressure. (b) *Forming within the*

intestine, such as accumulations of seeds (enteroliths), chemicals, taken either in food or water or as drugs, such as lime or bicarbonates (coproliths), or particles of hardened fecal material (fecoliths). Any of these may cause traumatic injury in the same manner as other foreign bodies passing through the alimentary canal. (c) *Inserted per anum*. This class of objects includes instruments used either for examination or treatment, as bougies, proctoscopes, enema tips, thermometers which if inserted carelessly, too forcibly, hastily, or without due regard for possibly diseased tissue, may lacerate, puncture perforate or rupture the intestinal wall. Also, enemata if allowed to flow too forcibly, may pierce weakened membranes. In this division, too, are the various objects inserted by patients themselves or their friends, as a joke, as a means of "treating" constipation, hemorrhoids, etc., or for sexual perversion. In such cases, the shape of the object, its position or movement, the pressure it exerts, or the manipulation necessary to remove it may quite easily result in damage to rectum or sigmoid. (d) *Bullets* and fragments of shot or shell sometimes damage the rectum, but usually as such objects enter through this area they pass on up through the rectum to wreak their greatest havoc in the abdominal cavity. They are rarely found embedded in the rectal walls.

2 **Falls**—A fall on a narrow or pointed object resulting in impalement may damage the anus and rectum considerably. Also, a very forceful fall on a flat surface or a kick or other heavy blow, may cause abrasion, sloughing or even rupture. *Crushing blows resulting in fractured pelvic bones* almost invariably cause perforation of the gut.

3 **Strain**—This more frequently causes rupture than is commonly imagined. Such ruptures are of two types

(a) Spontaneous { Coughing
Defecation,
Unexplained.

(b) Traumatic { Lifting
Pressure { Pneumatic hose
Long retained foreign bodies

Accidents in industries which make use of the air pressure hose are not infrequent the result either of careless handling or a practical joke.

Treatment—For the superficial types, that may be encountered in other parts of the body, such as abrasions, burns, and surface lacerations, the treatment is the same as that employed when they occur elsewhere, modified somewhat by the fact that the perianal skin is constantly contaminated by the bacteria found in the feces, as well as those usually present in and on the skin. Superficial wounds should not be closed tight by sutures or occlusive dressings, but if sutures are required they should be interrupted and widely spaced. Suture material that is nonabsorbable is preferable. If the patient is ambulant it is never advisable to use stiff sutures, such as wire, silk, worm gut, or the various synthetic dermal sutures, because of the discomfort. The material of choice is silk or linen.

The intrinsically more serious wounds, as punctures, perforations, and ruptures, are divided for purposes of treatment into two classes—those below the peritoneal reflection and those above it. It will be realized that determination of the exact location and extent of injury is most important. A history as exact as possible must be obtained and the examination must be methodical. First any external wound must be inspected then retracted and probed gently to ascertain its depth and whether or not the peritoneal cavity has been penetrated or any pelvic organ damaged especially the bladder. Escape of pus, feces or urine through any wound is, of course, a danger flag. Second gentle proctoscopy should be performed, and third if necessary and practical roentgenographic examination may be useful. It should be remembered that extensive external injury does not necessarily predicate severe internal injury nor, conversely does a small external wound, or even the absence of shock or hemorrhage, justify a diagnosis of slight internal damage. The general condition is also an important indication.

Treatment, to be most effective should be prompt. In wounds below the peritoneal reflection thorough debridement of the area and establishment of adequate drainage with care as to cleanliness in the after treatment will usually achieve satisfactory healing. However for severe or extensive injuries, which may require a protracted period for healing such as bullet wounds colostomy is generally recommended to protect the area from the contamination and irritation of fecal

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passage Here, again, suturing is a debatable question It is believed that direct suture is indicated only in wounds of the peritoneal portion of the rectum, ordinarily the circumstances of each case should decide Ample excision of dead tissue in the rectum offers more protection against pelvic cellulitis and diffuse gangrene than colostomy

Wounds above the peritoneal reflection are really abdominal cases and require immediate laparotomy, repair, and drainage Here the time element is of utmost importance Fansler states that in rupture due to the pneumatic hose about 50 per cent of cases recover if operation is immediate, but if operation is delayed the mortality is over 90 per cent

Indeterminate cases in which the physician is uncertain whether or not the injury extends above the peritoneal reflection, will fall into either of the two categories above after observation of the general symptoms Absence of severe abdominal disturbance justifies expectant treatment, and if such a condition does not occur for twenty four hours, operation may be considered unnecessary In the presence of acute abdominal symptoms however the case immediately falls into the second classification and laparotomy is imperative In doubtful cases, also, x ray with the patient in the erect position will show air under the diaphragm

OPERATIVE WOUNDS

Most of the wounds of the anorectal region are those resulting from operations These can be classed as those that are primarily clean wounds in the sacral region around the anus or in the rectum and those that are the result of the operative treatment of a condition that is primarily infective

Under the first group come the wounds resulting from the repair of congenital defects of the anus or rectum the removal of pilonidal cysts and sinuses that are not infective hemorrhoidectomy papillectomy the destruction or removal of intra rectal polyps or other tumors proctotomy for stricture and the like These wounds are all clean primarily but soon become infected by fecal contamination

In the second group are the wounds resulting from excision of anal fissure or ulcer excision or incision of fistulae and incision and drainage of abscesses either superficial or deep

These wounds are all primarily infected because the original lesion is an infection. In general such wounds are quite extensive because the lesions are large and there is much damaged tissue that must either be removed or separated secondarily.

The first principal in the treatment of all wounds in this region is adequate drainage. The fact that all such wounds are primarily infective or quickly become so, means that all surgical incisions must be so constructed as to entail the minimum of infection and permit the maximum of cleanliness. Anatomically this precaution is necessary because the tissues about the rectum are soft and loose and tend to fall together.

Primarily infected



excision of fungus or anal ulcer
incision or excision of abscess
incision and drainage of abscesses
(superficial or deep)

Primarily clean



hemorrhoidectomy
parastomal
polypetumors etc.
perianal cyst

Fig 487

to close small defects thereby reducing the size of wounds that look adequate when first made. While this tendency to mechanical closure is an aid in the healing of large defects the disadvantage of premature closure and interference with

healing are great. The approach to the superficial and cause the secondary breaking down of the area, or a recurrence of the condition for which operation was originally undertaken.

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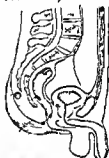


excision of fissure or anal ulcer

incision or excision of fistula

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Primarily clean



hemorrhoidectomy

polypectomy

polypetumore etc

pilonidal cyst

Fig 487

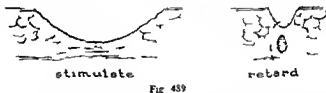
to close small defects thereby reducing the size of wounds that look adequate when first made. While this tendency to mechanical closure is an aid in the healing of large defects the disadvantage of premature closure and interference with drainage before proper healing occurs is very great. The approximation of the walls of wounds, particularly the superficial edges may imprison bacteria and discharges and cause the secondary breaking down of the area, or a recurrence of the condition for which operation was originally undertaken.

It is a fact that the average patient seems to develop a partial immunity to the bacteria with which he lives, and there-

fore rarely develops violent wound infections unless the wound is contaminated with organisms to which he has not had an



opportunity to develop some degree of resistance. Primary abscesses or other localized pus collections also develop some



local immunity in the tissues surrounding them. As to secondary infection, the dressings and general care in all wounds



- 1 Wide excision
- 2 Adequate drainage
- 3 Cleansing and Antiseptics
- 4 Regulation of rate of Healing
- 5 Relief of Pain

Fig 490

must be such that there is no chance of such a development. This means that cleanliness both mechanical and surgical is imperative in the after care. Secondary infection will cause

a greater local reaction and will invariably delay healing. Cleanliness and the use of antiseptics are the defense against such invasion. Mechanical cleansing of the wounds after defecation must be gentle and thorough. Frequent change of dressing and the removal of wound discharges is important. This means that soon after the operation wet dressings must be applied and frequently changed. Later in the postoperative care, hot sitz baths with the liberal use of soap applied with cotton or soft gauze followed by careful drying, is more important than the sole use of any of the polychromatic antiseptics that are now so popular.

In addition to care in selecting the type of wound and the postoperative dressings the routine must include the relief of pain and sphincter spasm. The generous nerve supply of the anal and perianal region means that wounds in this area are more painful than those in some other parts of the body. With stimulation of these pain nerve endings there occurs secondary sphincter spasm which increases the pain, thus forming a vicious circle that must be broken if the patient is to be made comfortable. The hypodermic use of morphine postoperatively may be necessary. Sometimes the milder analgesics by mouth will serve the same purpose. A very simple and effective aid in the postoperative comfort of the patient is the injection of some of the more enduring analgesics in the operative field at the time of operation. These injections can be used only in cases that are not primarily infective. Either diothane or the oil soluble preparation devised by Morgan under the name proctocaine is very satisfactory, and according to our experience does not delay healing.

After wounds begin to heal they must be watched so that, if necessary, this process may be either hastened or retarded. Too rapid healing may result in bridging of the wound and obstruction to drainage or the development of excessive granulation tissue with bleeding and discharge and, later, delay in the final scar formation. Some wounds become sluggish and the healing seems actually to cease in which case measures to stimulate healing may be necessary. The application of cod liver oil and radiolatum has been rewarded by good results.

The general principles of anorectal wound treatment, then include (1) adequate drainage, (2) prevention of secondary

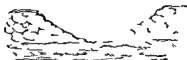
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venting a stenosis. This is repeated at least every week until healing is complete. Only rarely does the presence of excessive granulation tissue require the application of silver nitrate 10 to 20 per cent solution. The wound is usually entirely healed in about three weeks and after a month the patient can resume hard physical labor requiring lifting or straining. Ordinarily the patient is able to return to work one week after discharge from the hospital.

Proctotomy for rectal stricture should be performed only in annular type cases. The procedure is useless in those with long tubular strictures or where the rectum is "pus ridden" as is so often seen in active lymphopathia venerea. In those cases where it is indicated it can usually be done under local analgesia, the resulting wound being simply a linear incision through the point of narrowing. The wound is entirely intrarectal and requires but little postoperative care. The stools should be kept soft by the use of mineral oil as described in the postoperative care of hemorrhoidectomy, and the rectum should be irrigated daily with some mild antiseptic solution until the wound granulates. The patient is better hospitalized for a day or so. The postoperative drainage is especially important in these cases and is best accomplished by the presence of

those strictures which are within reach of the index finger. The dilators should have a rounded tip, and a size small enough to be passed very easily should always be used first. The increase in sizes must be very gradual and no effort should be made to dilate the bowel to the normal size. These dilations should be continued over several months, after which the patient must report for periodic examination and dilatation until at least a year after operation. The majority of inflammatory rectal strictures that we see are cases of lymphopathia venerea and as a rule the patient does not apply for treatment in the early, acute stage, when proctotomy is advisable, but in the very late stages. In the latter instances there is often a very long tubular stricture with a very small lumen, for which we believe that the only operation of any real value is a colostomy, followed in some cases by a perineal excision. For these

infection, (3) prevention of pain and sphincter spasm and (4) measures to retard or stimulate healing. Let us see how these principles are applied to the actual treatment of the different types of postoperative wounds.

Hemorrhoidectomy—At operation the wounds resulting from the removal of external or internal hemorrhoids, either by clamp and cautery or ligature, should be extended out onto the perianal skin for a distance of from one half to three quarters of an inch. The sides of the wound should converge to meet at a point. The actual size of the wound will depend upon the size of the external hemorrhoidal mass that has been removed. Such a wound allows drainage from the anal canal and prevents healing of the outer portion before the upper rectal and anal parts have healed. Occasionally, if the outer portion of the wound is made very long sutures of chromic catgut or silk may be inserted to close it partially. If there is evidence of infection the sutures should be removed. At the end of the operation a small piece of gauze impregnated with vaselin or dichloramine T is inserted into the anal canal and dry dressings are applied. This acts as a wick drain and is removed at the end of twenty four hours. The area is then cleansed and dressings kept moist with hot boric acid solution are applied to the perineum. They are kept warm by the application of a hot water bottle to the outside of the dressing and must be changed at least three times a day. Provision for soft bowel movements is made by giving mineral oil daily and a dose of some laxative as castor oil the evening of the second day. The mineral oil is continued until the wounds have entirely healed. The first bowel movement takes place with the patient in bed and using a bed pan. The day following he is allowed to go to the toilet but is advised not to strain at stool. After this he is allowed up every day as the erect position aids drainage. He is given hot sitz baths at least three times a day, particularly after a bowel movement. He is allowed to leave the hospital on the third or fourth day but must continue the mineral oil and sitz baths at home and return to the office or clinic at first every day and then every second or third day until the wound has healed. On the tenth postoperative day the well lubricated finger or a small metal sound is passed into the anal canal in order to break up adhesions thereby pre-

prevent bridging it can heal only from the bottom by granulation and this is always a slow process. After a good bed of granulation tissue has formed stimulating drugs such as the sulfhydryl groups, allantoin or crude cod liver oil may be used or the wound may be exposed to ultraviolet light twice or thrice weekly. Skin grafting may be used but the difficulty of keeping a pressure dressing in place with the patient ambulant usually means failure. The patient had best be told before operation that the usual length of time for firm healing will be from six weeks to two months. If he understands this he will not be so apt to become impatient and demand that the physician resort to unwise procedures to hasten the healing. This would entail the danger of breaking down the scar which the patient will always interpret as a recurrence of the original lesion.

Excision of the rectum as the last stage of an abdominoperineal resection results in the most extensive perineal wound of any of the lesions that are not primarily infective. Although the fecal current has been diverted by a preliminary colostomy these wounds always become infected to a greater or less degree. While a few interrupted nonabsorbable sutures are inserted to close the wound and hasten healing adequate drainage must always be provided. This is usually accomplished by the insertion of a firm pack of gauze enclosed in a sheet of rubber dam.

Ischiorectal or pelvirectal abscesses result in the most extensive wounds of all the conditions that are primarily infective. These lesions may reach a considerable size and as they must drain freely to hasten complete recovery the incision must be large and a sufficient area of skin must be removed at operation to prevent too rapid superficial healing. We believe that if packing can be inserted easily and yet will remain in place the wound is not large enough. About 50 per cent of these patients will have a fistula as a result of the lesions because the infection starts in a crypt at the anorectal line and at operation with the swelling of the tissues and consequent distortion this tract can only rarely be located. The danger of a secondary fistula being known it is well to make the wound as near the external sphincter but just beyond its outermost fibers as the drainage of the most dependent portion of

a proctotomy is seldom performed. Rectal papilloma or other small intrarectal tumors, when not malignant are usually removed by electrocoagulation or desiccation and therefore require little care. The treatment is the same as that mentioned in proctotomy so far as the use of mineral oil and low rectal irrigation is concerned. The case must be watched for the first week after operation so that a secondary hemorrhage may not develop unobserved. This is especially necessary because these patients are rarely hospitalized. In addition to the immediate postoperative routine these patients must be instructed to return at intervals for the next year or two at which time the area involved should be carefully examined for any small recurrence since there is always the possibility that the growth may have been malignant without showing as such at the pathologic examination. Should there be any recurrence this must be promptly destroyed after a preliminary biopsy.

Pilonidal sinuses or cysts are usually excised en masse and the wound left open to heal by granulation. Ordinarily these wounds are rather extensive and deep. They are packed with gauze after operation and this packing either removed the second day or allowed to remain in place for four or five days. Early or late removal is not so apt to cause pain or bleeding as removal during the interval. These patients are usually hospitalized as the anesthetic is either general or spinal but they can be discharged by the third or fourth day. The wound does not involve the anal region and the patient is allowed to use the toilet therefore the wound is not so apt to become grossly contaminated with feces. Following the first dressing when the packing is removed the wound is cleaned and lightly repacked with sterile gauze. Because of its size there is usually a considerable amount of drainage and this requires daily dressings for the first two weeks. During this time the wound is kept clean and the hair that tends to grow at the wound margin is kept closely shaved as the formation of scar tissue in the process of healing tends to draw the wound margins down so that unclipped hair may act as an irritant.

These wounds seem to heal very slowly but it must not be forgotten that the block of tissue removed is large and the wound nearly always becomes contaminated. Since the upper margins of the wound are kept apart in an effort to

prevent bridging it can heal only from the bottom by granulation and this is always a slow process. After a good bed of granulation tissue has formed stimulating drugs such as the sulfhydryl groups, allantoin or crude cod liver oil may be used or the wound may be exposed to ultraviolet light twice or thrice weekly. Skin grafting may be used but the difficulty of keeping a pressure dressing in place with the patient ambulant usually means failure. The patient had best be told before operation that the usual length of time for firm healing will be from six weeks to two months. If he understands this he will not be so apt to become impatient and demand that the physician resort to unwise procedures to hasten the healing. This would entail the danger of breaking down the scar which the patient will always interpret as a recurrence of the original lesion.

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Ischio-rectal or pelvirectal abscesses result in the most extensive wounds of all the conditions that are primarily infective. These lesions may reach a considerable size and as they must drain freely to hasten complete recovery the incision must be large and a sufficient area of skin must be removed at operation to prevent too rapid superficial healing. We believe that if packing can be inserted easily and yet will remain in place the wound is not large enough. About 50 per cent of these patients will have a fistula as a result of these lesions because the infection starts in a crypt at the ano-rectal line and at operation with the swelling of the tissues and consequent distortion this tract can only rarely be located. The danger of a secondary fistula being known it is well to make the wound as near the external sphincter but just beyond its outermost fibers as the drainage of the most dependent portion of

the abscess will permit. This insures a short tract if a second operation has to be performed. Following drainage the wound is packed lightly with a thin strip of vaselin gauze this to be removed in twenty four hours. When the wound has been cleaned it may be repacked. The external dressings are changed three times a day and the wound is thoroughly dressed once a day, care being taken to break up bridging tissue by means of dry gauze or a dry cotton applicator. The loose perirectal tissues tend to fall together preventing drainage and allowing healing of the walls before granulation tissue can fill it from the bottom. The patient is given mineral oil daily, and following the first movement the wound must be carefully washed and redressed. The patient is allowed out of bed by the third day as the erect position aids drainage. Hot sitz baths are started after the bowel movement and are continued three or four times a day thereafter for the first week. This affords the patient much comfort and keeps the wound clean so that healing progresses unhindered. Dry dressings can be used after the sitz baths are started and these are held in place by a T binder. The wound is dressed at least every third day after healing is well begun and until it is complete. Excessive granulation tissue is removed by dry gauze curettage with silver nitrate and in this stage any of the various stimulating applications used in the after-care of the pilonidal wounds may be employed.

Wounds resulting from the incision or excision of a fistula are also primarily infective but are usually not so deep as those consequent upon the drainage of abscesses. They also are packed after operation but the packing is removed on the second day. They are cared for in the same way as abscess cases with one exception where the sphincter muscle is divided as is usually necessary, the wound resulting from the divided muscle is repacked after because they

both unite to the block of scar tissue resulting from the healing of the tract. If they are kept too far apart the cicatrix is large and then even though the muscle contracts properly it is larger on one side than the other and cannot close the anal canal tightly. The result is more or less interference with the

normal defecatory mechanism. The postoperative dressings include the light packing of the outer portions of the wound but the area through the sphincter muscle is only separated by the gloved finger and never repacked. If the anorectal ring has not been divided at operation any severe degree of incontinence or interference with the defecatory mechanism is the result of improper after care. The preliminary wet dressings and the sitz baths are used as in abscess cases as is the careful toilet after bowel movements.

Postanal infection frequently called anal fissure or anal ulcer requires the same postoperative routine as the hemorrhoidectomy. In these cases the external sphincter muscle is either gently divulsed at operation completely or partly divided or one of the lengthily effective analgesics is carefully injected. These injections must always be made well outside the area of the lesion to prevent infection from the needle. The external wound is extended onto the skin to assure healing of the anal portion before the external portion. This provides the necessary drainage. The routine of medication to control pain wet dressings and later sitz baths together with mineral oil to produce soft bowel movements is the same as in the case of a hemorrhoidectomy.

The wounds from other anal operations including the removal of hypertrophied papillae and crypts are given almost the same care but as these cases are usually not hospitalized the patient must be more carefully instructed in order that he may give himself proper care at home.

In summary the treatment of anorectal wounds is based upon the following principles: (1) adequate drainage both at operation and postoperatively; (2) prevention of secondary infection so far as it is possible; (3) relief of pain and sphincter spasm; (4) stimulating or retarding healing as the individual case may require. These principles may vary somewhat in their application in the different cases but furnish the basis of all after care following the various operations in proctology.

the abscess will permit. This insures a short tract if a secondary operation has to be performed. Following drainage the wound is packed lightly with a thin strip of vaselin gauze this to be removed in twenty four hours. When the wound has been cleaned it may be repacked. The external dressings are changed three times a day and the wound is thoroughly dressed once a day, care being taken to break up bridging tissue by means of dry gauze or a dry cotton applicator. The loose perirectal tissues tend to fall together preventing drainage and allowing healing of the walls before granulation tissue can fill it from the bottom. The patient is given mineral oil daily and following the first movement the wound must be carefully washed and redressed. The patient is allowed out of bed by the third day as the erect position aids drainage. Hot sitz baths are started after the bowel movement and are continued three or four times a day thereafter for the first week. This affords the patient much comfort and keeps the wound clean so that healing progresses unhindered. Dry dressings can be used after the sitz baths are started and these are held in place by a T binder. The wound is dressed at least every third day after healing is well begun and until it is complete. Excessive granulation tissue is removed by dry gauze curettage with silver nitrate and in this stage any of the various stimulating applications used in the after care of the pilonidal wounds may be employed.

Wounds resulting from the incision or excision of a fistula are also primarily infective but are usually not so deep as those consequent upon the drainage of abscesses. They also are packed after operation but the packing is removed on the second day. They are cared for in the same way as abscess cases with one exception where the sphincter muscle is divided as is usually necessary the wound resulting from the excised fistula must never be tightly packed or repacked after the first forty-eight hours. The ends of the divided muscle do not heal primarily but are able to function because they both unite to the block of scar tissue resulting from the healing of the tract. If they are kept too far apart the scar area is large and then even though the muscle contracts properly it is larger on one side than the other and cannot close the anal canal tightly. The result is more or less interference with the

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JEFFERSON HOSPITAL

SKIN LESIONS IN SURGERY

THE surgeons were the first dermatologists—excellent ones in some cases—so it is but an evidence of survival value that we still find a kinship which attracts many borderline instances to the former rather than the latter specialty. Conditions which in general present localized swelling tumor formation pus collections or such subjective symptoms as pain or throbbing are as apt to gravitate to the surgical as to the skin practitioner whether impelled by their own inclination or directed by their family medical attendant.

A visit to a large surgical dispensary by a dermatologist may readily obtain for him sights of interesting skin conditions serve to assist the surgeon in the differential diagnosis of puzzling complications and sometimes help in averting improper treatment at the hands of the student intern or novice.

Comparatively newly recognized are some of the rarer fungus and bacterial diseases which affect the skin chief among which might be mentioned such conditions as sporotrichosis blastomycosis some clinical forms of tularemia actinomycosis or even Madura foot. Of these probably the most readily recognized is sporotrichosis. The error in diagnosis is usually a confusion of its chain of granulomas with a simple pus infection with secondary abscesses springing up along the course of the lymphatic vessels draining a single furuncle. Naturally the more typical the appearance of the sporotrichotic lesions the less chance of mistake. When one is aware of the existence of such a disease it is not difficult to spot it on account of its bizarre character when typically developed. The earlier it is seen the greater the difficulty in recognition. A few months ago such a case was noted with probably 10

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nodules extending upward from an initial focus on the thumb. They were regularly spaced and in quite a straight line up the forearm. With the exception of the last two swellings they had all been opened and drained by packing though but little pus had been obtained and no clinical benefit ensued. The first one or two incisions were possibly pardonable mistakes; the later lesions were treated with an increasing degree of error. However the condition is so rare in the eastern states that one should not blame the attendant too greatly.

A much more common condition is *tinea kerion* seen on the scalps of children—inflammatory ringworm. A beefy red rounded—sometimes semiglobular—swelling with a base about the size of a quarter dollar will be noted to have a number of small pustular points appearing at various parts of the surface. If lightly pricked and pressed upon but little material can be forced out. The almost complete hair loss on the surface, the presence of other lesions of a similar type or more closely approaching the usual form of *tinea tonsurans*, history of contagion and presence of the causative fungus should restrain one from more radical surgical procedures. Frequently not only a single deep cut has been made into the swelling but a crucial type of incision has been employed. These procedures only serve to delay resolution in these cases and at best leave disfiguring scalp scars which are entirely unnecessary as *tinea kerion* usually subsides without permanent trace. A similar warning applies to the outbreak of *erythema nodosum*. An early case with but 1 or 2 lesions deep seated slightly fluctuating inflammatory may readily be mistaken for *furunculosis* if one is not sufficiently wary or informed. A rule with few exceptions tells us that the disease in question does not break down spontaneously to discharge through the skin. Consequently an artificial opening only serves to slow up the usual resolving process and is an example of meddling surgery. Nor should we forget that rarely *erythema nodosum* is seen on the forearms and the same principles are to be borne in mind for that location.

Syphilis as always must be reckoned with. The likelihood of attraction of that disease to a traumatized site in a luetic subject is a constant surgical possibility. This may apply to the late secondary as well as the tertiary cases.

The dermatologist must bow to the surgeon in regard to some of the end results of epithelioma treatment in so far as cosmetic effects are concerned. Too often the patient is left with a broad scar as a reminder of radium or electrocoagulation when the area could have been excised and but a linear cicatrix follow the treatment. If the region is adapted to such a procedure with promise of better appearance to follow by all means let excision be employed. Unfortunately the common sites of the basal celled variety are in situations where the skin is stretched too tightly for good plastic effect. It must likewise be weighed in judgment whether there is an occasional stress which will stretch the scar in healing and offset the desired result.

The treatment of keloid should belong to the dermatologist at least in part. It has been the fortune of nearly all of us to have observed the unhappy sequel to an excision of one of these growths—a surprising return with more than accrued interest. A pea sized lumpy scar with the necessary lozenge incisions for its complete removal may return in the shape and size of a small fig. Where the tendency to hypertrophic scarring exists one may rest assured that subsequent trauma will give the same stimulus as did the original injury. The old procedure of seton—a distinctly surgical operation—has recently been employed in reducing the size of disfiguring scars. Horse hair silk or fine silkworm gut sutures are run through the fibrous tissue in parallel fashion and are moved by pulling back and forth daily. This is said to afford reduction by drainage of the interior of the fibrous mass. However this may be I have known of several instances in which rapid improvement occurred following use of this method. The well known use of x ray and radium preceding and following excision is still probably the most popular course of action. As to x ray burns the old variety

of treatment is it a rule not to months have elapsed without progress. Even so the edges to be joined are apt to be of low resistance and unfitted for the task of bridging the gap. A large ulceration may result.

Chronic paronychia is a condition which does not as a rule yield one iota to lotions or salves. Its cure ordinarily is de

pendent on either roentgen or radium treatment or removal of the nail root. While this latter may be accomplished by avulsion of the whole nail I have always felt that there was a distinct advantage in leaving the body of the nail in place until it loosened or was pushed off by the new nail growth. Under local anesthesia the procedure is usually carried out by

1

scissors or scalpel and removed. The under side of the flap is scraped free of any granulation tissue which may be present and replaced. Sutures are usually unnecessary; disability is slight and results are excellent as a rule. For those reluctant to indulge in such an operation radiation treatment holds out a fair chance of success with no more pain than the presence of the inflamed nail fold would account for without treatment. Plantar warts are apt to be the bane of any physician's life—the dermatologist especially. All methods of attack have been known to fail—all have succeeded on occasion. I feel that the choice in order of preference is radium, electrocoagulation, x-ray and excision. I have known several instances where the last mentioned method caused long disability and resulted in failure or a scar as painful as the former wart. The operators were careful, competent men of the first rank.

Pea sized rounded swellings, usually somewhat elastic to the touch, are often noted on the dorsal surface of the hands in the neighborhood of phalangeal joints or at the base of nails. They occur over the sites of bursae. For want of a better name they are known as synovial lesions and contain a gelatinous material. Essentially chronic, they always recur when incised and usually when excised. x-Ray and radium nearly always give better results than the surgeon can accomplish by the other means.

One of the conditions which try men's souls is the treatment of bed sores, especially under certain adverse conditions. When a patient is incontinent, with the affected region apt to be flooded or soiled at any time, barring constant vigilance, then
 as are tried to the limit. The same
 those so injured
 losing severe and

continuous pressure on some dependent part. Prophylactic measures are not to be considered, for the dermatologist is called in usually when the decubitus is well excavated. Either side is glad to turn over its treatment to the other and both willingly commit it to the nursing staff. With all the remedies advocated for this condition there is little doubt that nursing care is the outstanding factor.

It is not an uncommon circumstance to observe an eruption usually on the lower leg when a cast is removed. The patient may give warning that such a complication may be expected by complaining of itching while the cast is still in place. The outbreak is of a scaly nature, inflammatory and suggestively rounded in its component parts. Undisturbed by scratching and encouraged by heat, moisture and darkness it will present typical clinical pictures of dermatophytosis. Such a patient will almost invariably show evidences of athlete's foot. While fungus forms may be readily demonstrated in the foot scales they may be absent in the portion beneath the cast which not infrequently is a dermatophytid—a toxic outbreak simulating the fungus containing eruption but noninfectious. Once open to the light and tangible the appearances rapidly respond to such banal remedies as sulfur iodine and the like in proper strength. The ringworm eruption must be distinguished from prickly heat and dermatitis from pressure rubbing or chemicals employed before the cast was applied.

Hampered by an all pervading odor which hurts its legitimate uses iodoform is doubly damned when it produces a local or even a generalized dermatitis which may perversely resemble surgical scarlet fever or a toxic erythema. Perplexity at noting a redness around a wound packed with iodoform gauze may include the thought of erysipelas.

Necessary injections of various sera especially tetanus antitoxin are fortunately less objectionable from the standpoint of hive formation than they were at an earlier period. Improvement in relation to bulk type of incidental protein content and occasionally substitution of bovine for equine source, has materially diminished the annoyance to patient and surgeon. Absence of surface signs or localization to the injected region is the rule rather than the exception nowadays.

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The usefulness of dyes and highly colored preparations—excepting iodine—is still a somewhat clouded subject. Color is apt to appeal to the psyche and to have virtue ascribed to it from its visual qualities alone. The profession is still in a flux as to the effects of such preparations. Once swayed strongly in their favor many are found to have reacted to the opposite opinion. Bactericidal and fungicidal effects are often limited by the excellent resistance of the patient's tissues for the time protecting the parasites against the remedies. Whatever the surgeon's experience may be in this respect one feature turns me against the highly colored group—the inability to carefully watch the signs of the dermatosis. When indelible stains mask the outbreak progress cannot be properly observed without several days' intermission from treatment. This cure — e

addition to progress notation
 t dyes often prove a serious hindrance to diagnosis when the case is seen for the first time. Many physicians artlessly paint one of these preparations over the skin exhibits before referring a case for opinion thereby adding an obstacle to an outbreak which may already be a tax on the dermatologist's power to diagnose

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